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SAVING WASTE POWER

THE 66,000-VOLT DEVELOPMENT OF THE NORTHERN HYDRO-ELECTRIC POWER CO. AT HIGH FALLS, WISCONSIN

BY ARTHUR L. RICE

TO MAKE THE MOST of our sources of natural wealth is one of the important things which at present are occupying the attention of many of the brightest engineers. As a nation we are realizing that the sources of coal, oil, peat and other fuels are not inexhaustible, and that these great public stores are not fit subjects for lavish waste. It is, therefore, natural to turn to other sources of power, such as rivers, tides and sunlight, which show no diminution with the years, and try to utilize them to the fullest advantage.

Rivers are the only one of these 3 which have so far been harnessed satisfactorily. There is no reasonable question but what in the near future great progress will be made in utilizing the heat from the sun and the power of the tide, and possibly of waves, for doing useful work, but that time has not yet arrived. Meanwhile in numberless streams thousands of horsepower are daily running to waste for one reason or another. For the main part, it is because the power available at any point is too small to be worth the expense of developing, or is too remote from any place where the power developed could be utilized.

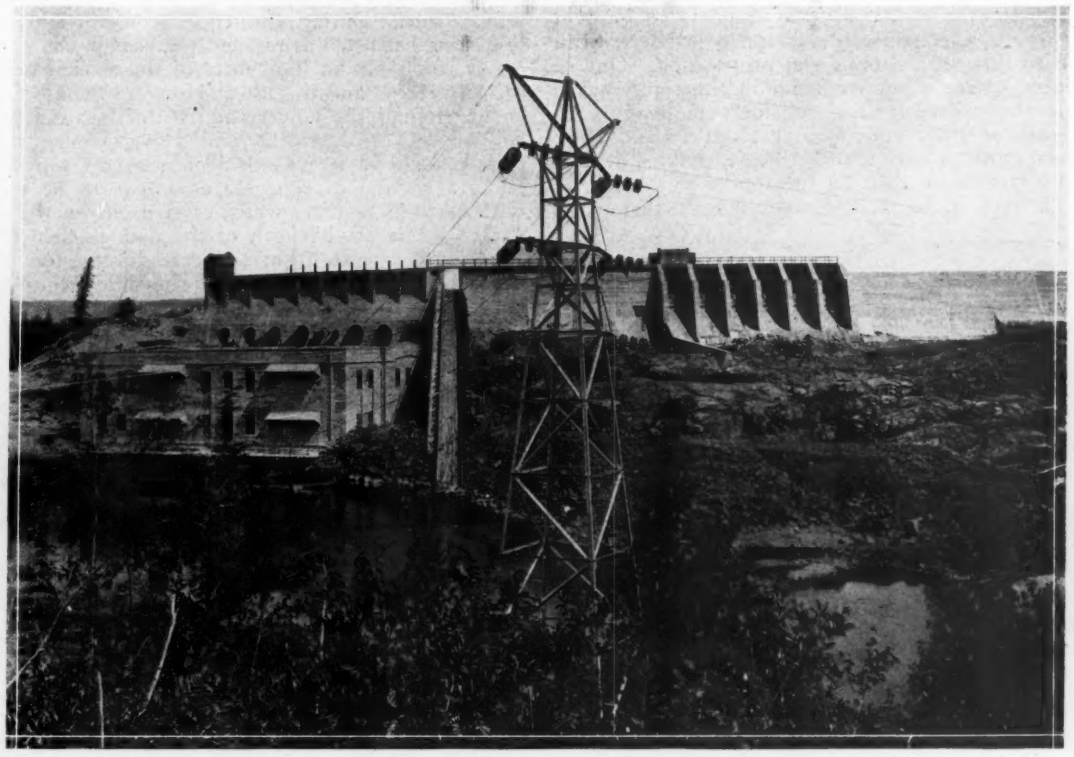


FIG. 6. TAINTER GATES, LOG SLUICE AND HEAD WORKS, WITH POWER HOUSE BELOW. ANGLE POLE IN THE FOREGROUND.

This latter condition is, however, being overcome by long distance, high voltage transmission, so that there is now hardly a waterfall of any size which cannot be profitably developed.

Location

IN the northern part of Wisconsin, through a section having as natural scenery largely sand hills, jack pines, and the wild pea, flows the Peshtigo River, an attractive trout stream with trout in it. At any rate, we saw one taken from it and there might be others.

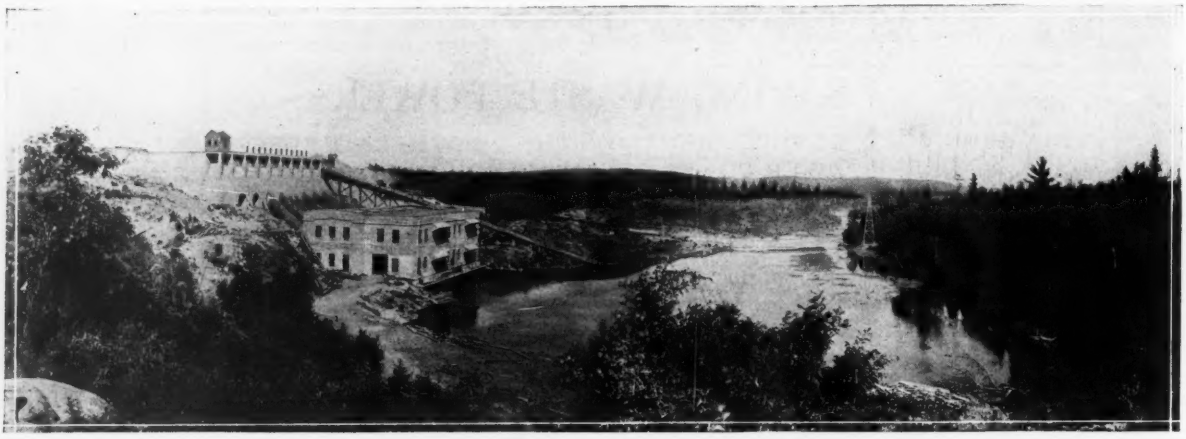


FIG. 1. GENERAL VIEW OF HIGH FALLS PLANT

At various points on the river are rapids and waterfalls, but for the most part the slope is so gradual that only in a considerable distance is there head enough to furnish a commercial proposition. One of the places where a sudden bend in the river makes possible the securing of a considerable head is 15 miles east of Ellis Junction, at High Falls. Here the river tumbles over a rocky ledge, making it possible, by erecting a dam on the top of this ledge, to secure a head of 85 ft. and some 3 miles below, as

FIG. 3. HIGH FALLS AS IT WAS

the river flows, but only a mile and a half across country is Johnson's Falls, with a head of some 40 ft. Between the 2 a considerable drop takes place, with a gradual slope and over small riffles.

Studying the possibilities it seemed that a dam at High Falls and a pipe line from this across country to deliver below Johnson's Falls, would give a large power at a reasonable outlay, but plans often go twisted and the franchise for the pipe line was not available. The Northern Hydro-Electric Power Co. went ahead, however, to do the best possible thing under the conditions and under the energetic lead of F. H. Josslyn, president, decided to erect 2 plants, one at each falls, and combine their output on a single transmission line which would carry the power to Green Bay, Wis., and possibly to Menominee and Marinette. Study of the situation was therefore made by Professor Daniel W. Mead of the University of Wisconsin, who designed the plant, and the location of the dam at High Falls was chosen and the layout of the work made. During the entire construction V. H. Reineking has acted as resident engineer in charge.

At this point in the center of the stream bed was a rocky ledge, and to either side were banks of sand. In developing the power the natural location for the spillway, control, works and power house was at this ledge, and it was decided that on top of this ledge a section of concrete dam was to be erected, with earth-filled wing walls, carried out on the sandy shores. The total length of the dam is 4900 ft. and the height 100 ft. from tail race to the top of the control works, the head in springtime being 85 ft.,

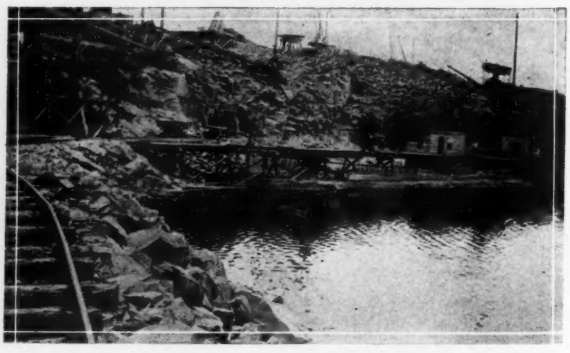


FIG. 4. MAKING READY FOR THE POWER HOUSE

which will be drawn down to 65 ft. during the dry summer months. The plant at Johnson's Falls was left for later development and work on it has progressed slowly, but will be carried forward to completion as soon as the High Falls plant is finished.

The stream is not subject to great fluctuation of level as is the case in rivers which are fed from mountains. A spring high water mark of 4 ft. above

the summer level is about the maximum and while provision has been made for taking care of a higher head than this it is not likely to be called into use. The drainage area is some 600 sq. mi. of the rolling, sandy country of Wisconsin, the feeders for the stream being largely small brooks.

Transmission

AS to possible use of the power, the present centers of population are Green Bay, Marinette and Menominee. Green Bay is, of course, the chief user of power in this vicinity, but the old experience that where cheap power is available there manufacturing will spring up, so long as there are transportation facilities, makes any point along the lines of the C. & N. W. or C., M. & St. P. railroads in this vicinity a possibility as a manufacturing center. It is probable, however, that Green Bay will absorb all the power which the plants will develop.

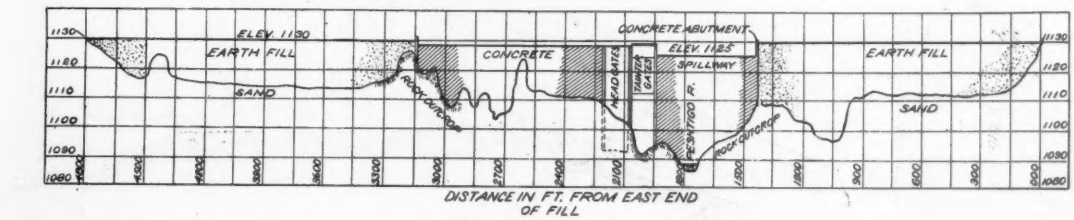
With the general scheme of the development in mind the transmission line starts from High Falls direct to Johnson's Falls, which is nearly due east, and from there strikes southeast toward Green Bay. At Johnson's Falls provision is made for cutting the future station on to the transmission line.

The towers are of steel, arranged with 3 crossarms carrying 6 wires, making a double 3-phase line. On top of the crossarms are 2 side prongs, carrying ground wires, and a lightning rod rises from the apex of the tower; 66,000 volts is the electromotive force for transmission, current being generated at 2300 volts and stepped up to the line voltage.

The Dam

FROM the eastern end the dam starts with an earth fill of which the cross section is the same as the abutment wall shown in the end of the concrete in Figs. 5 and 7. The upstream surface of this earth fill is covered with broken stone taken from the ledge foundation of the dam in the course of construction. The end of the earth fill is a concrete abutment, from which springs a concrete wall.

In this section of the dam, between the abutment and the spillway, are located gates to permit lowering of the level of the reservoir or draining it if that ever becomes necessary. At the end of this section is a stepped



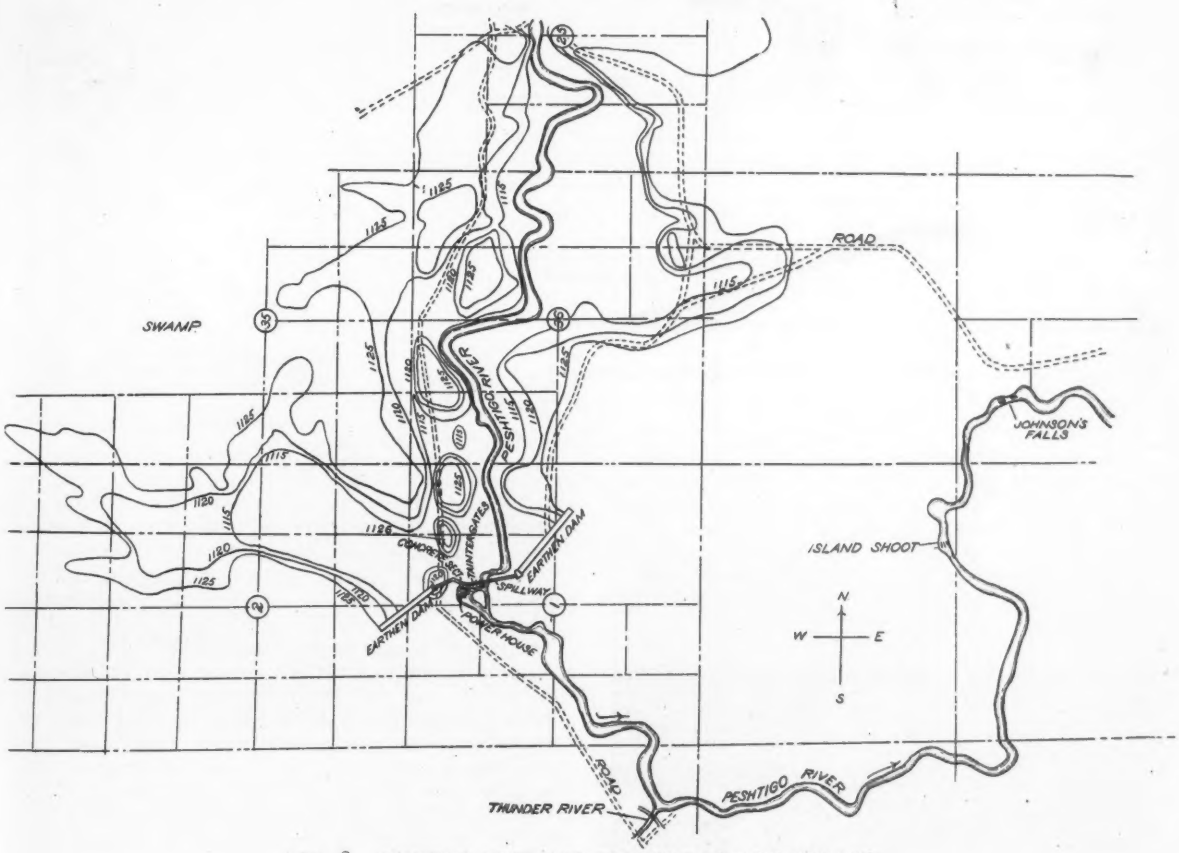


FIG. 2. PESHTIGO RIVER AND LOCATION OF DEVELOPMENT

abutment, and beyond this is the spillway for taking care of surplus water.

To the left of the spillway, looking upstream, come the tainter gates, Fig. 7, for controlling the height of water in the reservoir. These swing about axles of the dam from which the penstocks carry the water down to the power house, and at the upper end of each penstock is a head gate, with a trash rack run across the entire front of the forebay from which these penstocks lead. These gates are motor operated

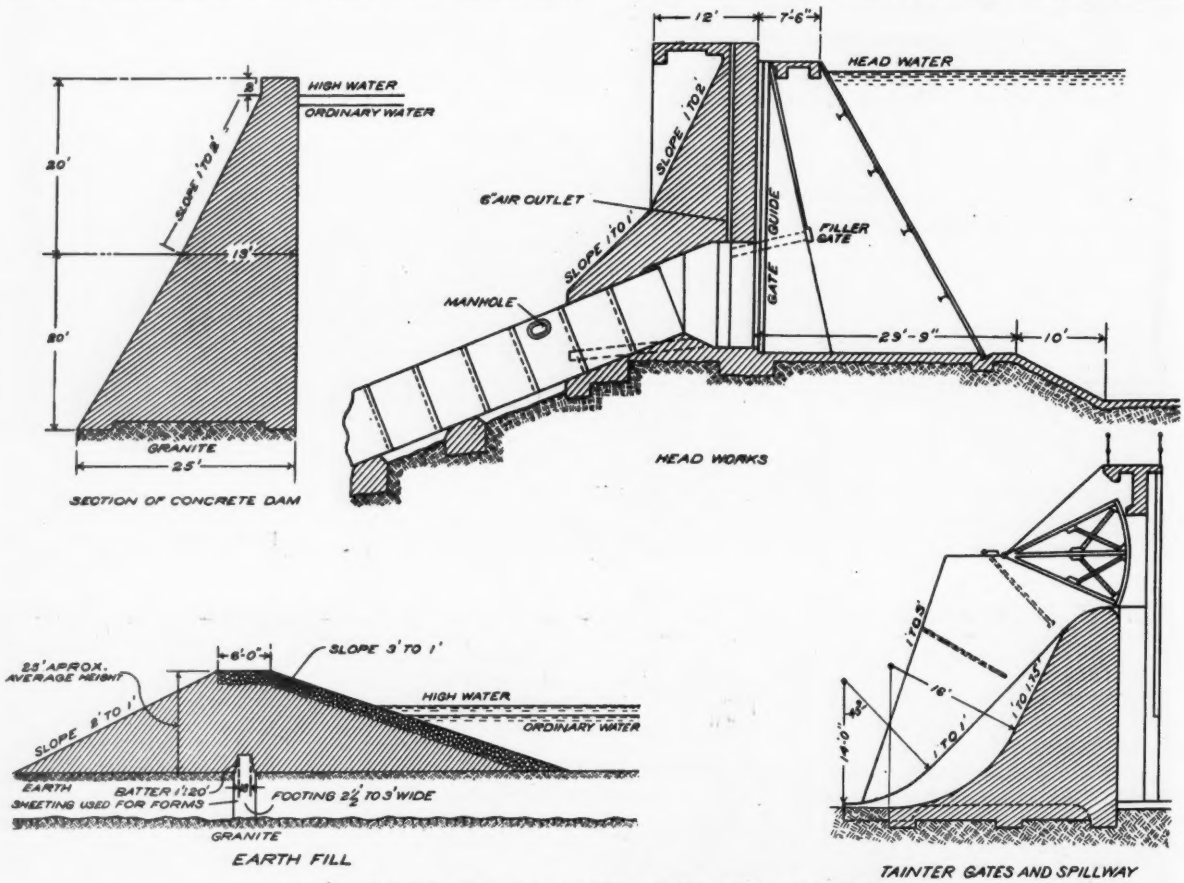


FIG. 7. SECTIONS OF DAM, TAINTER GATES AND HEADWORKS

and are controlled by a lift winch mounted on a carriage which runs along the track on top of the dam.

Still passing toward the left or western end of the dam comes a concrete section, and beyond this the log

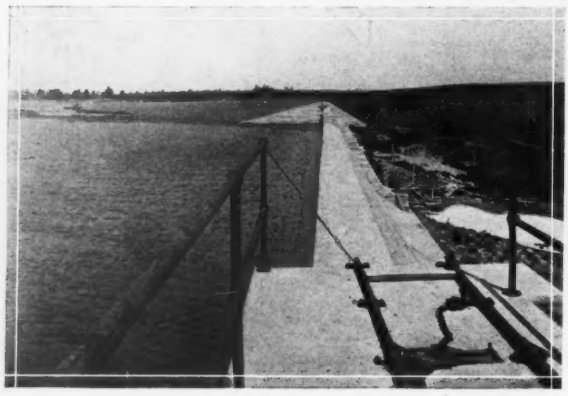


FIG. 5. EASTERN END OF DAM AND SPILLWAY

chute provided for the use of lumbermen when sending their winter's cut of logs down stream to the sawmills. Beyond the log chute comes the section by means of a winch carried on a track to serve the gate desired. Provision is made for 2 additional penstocks besides the 5 large ones and 2 small ones already installed. From the end of the dam beyond the power house the earth fill begins again and continues in a zigzag course far over the western bank of the river.

Although a rock ledge was available for the construction of a stone dam this is trap rock and does not split up in any regular form. It was thought advisable, therefore, to break this up and build the dam of concrete, also power house foundation, draft tubes, races and switchboard compartments, so that over 26,000 cu. yd. was built, Universal Portland Cement being used. The work of excavation and building of the dam was carried out by the Bates & Rogers Construction Co., of Chicago.

Power House Arrangement

THE power house proper, which is 136 ft. 6 in. long, is of concrete, with wire glass windows, steel framing and steel covered door and window casings and frames, making it as near fireproof as possible. The main generator room is open to the roof, with a Northern Crane carried on concrete brackets in the walls. In the switching compartment are 2 stories, the lower one carrying the transformers, oil storage

tanks and filters, and lightning arresters, while the second story carries the switches, control board, smaller transformers and low potential bus bars. The 66,000-volt bus bars are arranged below the floor of the second story in inverted trenches made by suspending asbestos board from the under side of the floor. Arrangement of the generating units is as shown in Fig 9.

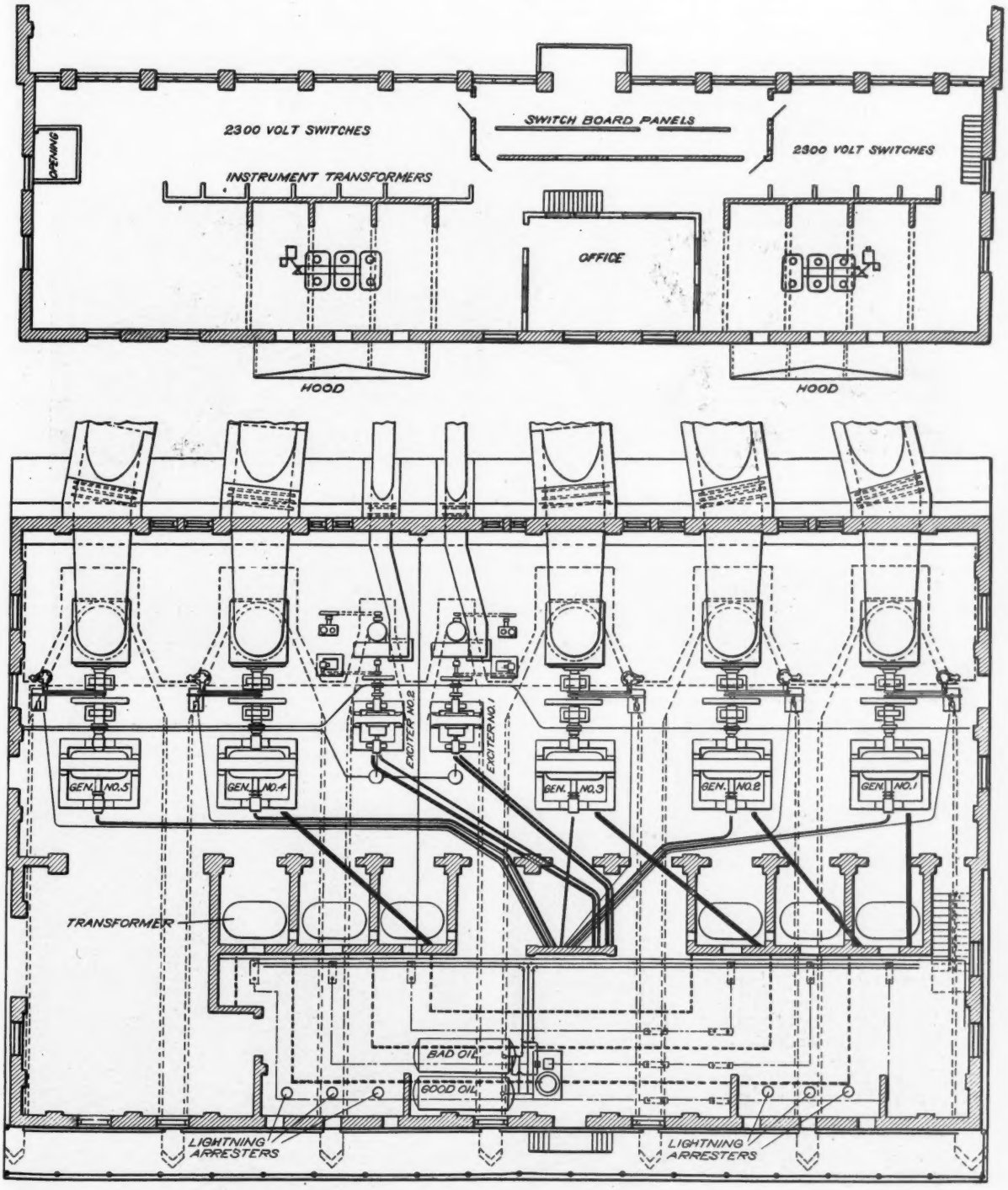


FIG. 9. PLANS OF POWER HOUSE AND LAYOUT OF MACHINERY

Water Wheels

FIVE main generators, each connected to its turbine, with rated capacity of 1900 hp. at 85 ft. head, generate current at 2300 volts. The 2 smaller units furnish exciting current at 120 volts, the capacity of each being 200 kw. The penstocks, made by the Lyons Boiler Works of De Pere, Wis., descend at an angle of some 30 deg. to the horizontal and deliver the water

through ¼ turn bends into the turbine casings. For the main generating units, these casings are cylindrical and the turbine runners are mounted, balanced, on a horizontal shaft, 2 to a generator. The exciter wheels have volute cast-iron casings, each carrying a single runner.

Control of the main turbines is by means of swinging guide vanes connected to cast-iron shifting rings, which is belted to the shaft, controls a pilot valve and this pilot admits or exhausts high pressure liquid from either end of the cylinder as may be necessary to open or close the vanes.

A dash pot and damper are arranged so that the governor shifts quickly with change of speed and the vanes are then shifted to a position where the

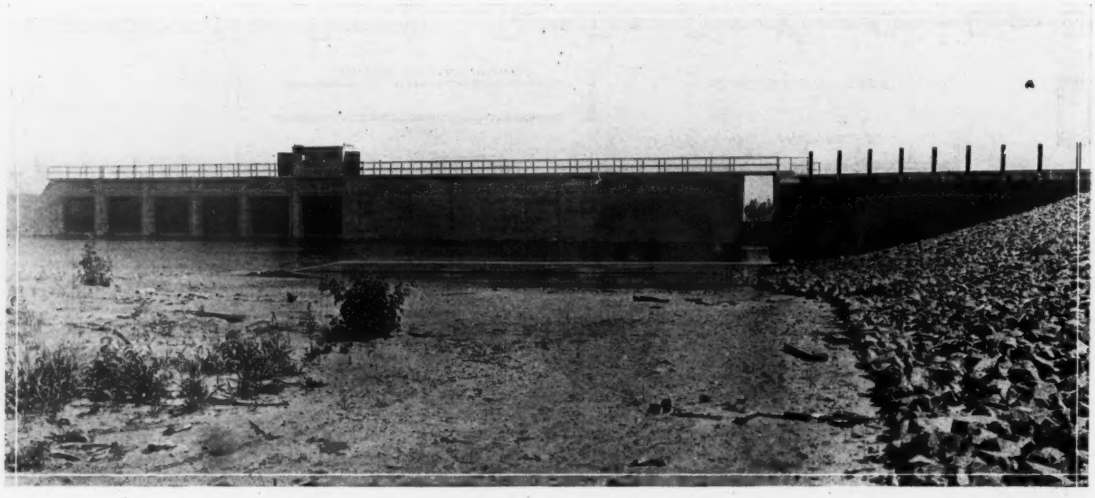


FIG. 8. HEADWORKS FROM THE INSIDE

and these rings are connected to the regulator shaft at 2 points by links.

Position of the rings and therefore of the guide vanes is controlled by a governor, which is of Allis-Chalmers special design. The actual shifting of the

speed will be as before at the new load. The normal load of each generator turbine is 1420 hp. at 80 ft. head and the maximum 1900 hp. For the exciter units the normal horsepower is 300 at 80 ft. head, and at 65 ft. head the rating is 250 hp. The efficiencies

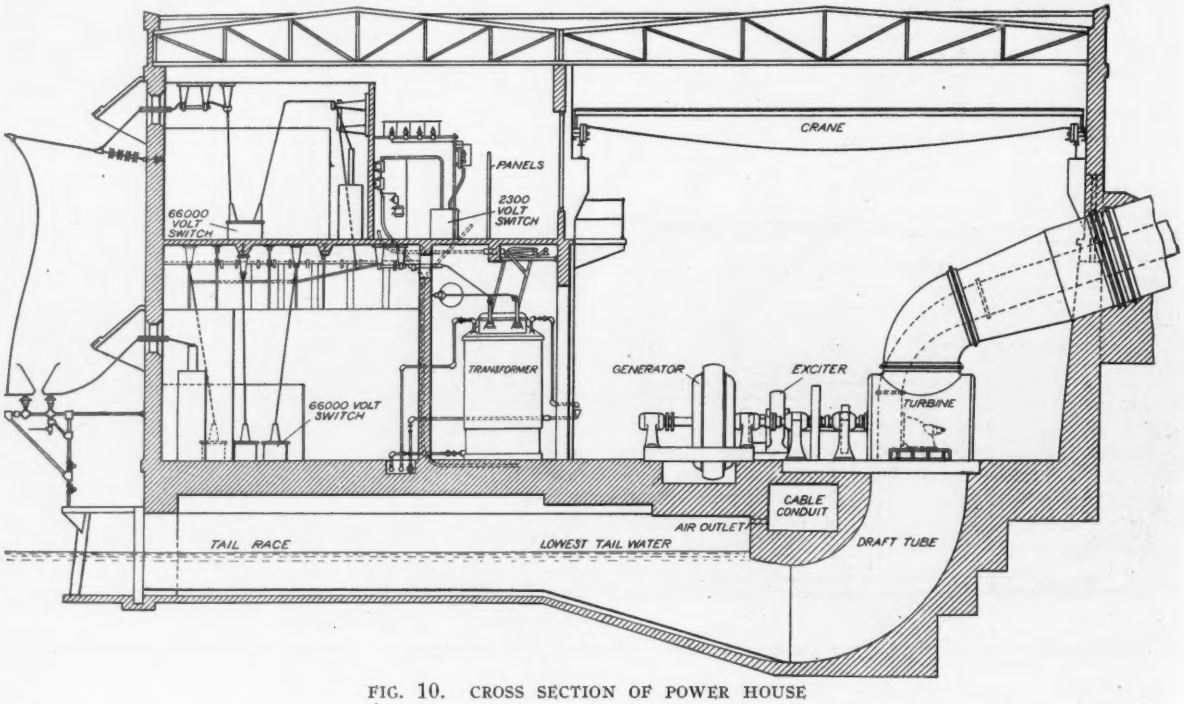


FIG. 10. CROSS SECTION OF POWER HOUSE

rings is performed by high pressure liquid, the pressure being maintained in a tank by a pump furnished by the Ludlow Valve Mfg. Co., and driven from the turbine shaft by means of a belt. The governor,

are to be 80 per cent at full load, 82 per cent at 0.75 load, and 75 per cent at 0.5 load.

To steady the momentary fluctuations a flywheel is used on the shaft of each turbine unit, this being

considered necessary because the plant will carry railroad load with its rapid and heavy changes in demand for power.

Generators

EACH of the main generators will have a capacity of 1000 kw. at a power factor of 0.9. They are the 8-pole, revolving field type, generating 279 amperes per terminal, 3-phase currents at 2300 volts and 25 cycles per second. The weight of each generator complete will be 62,000 lb.

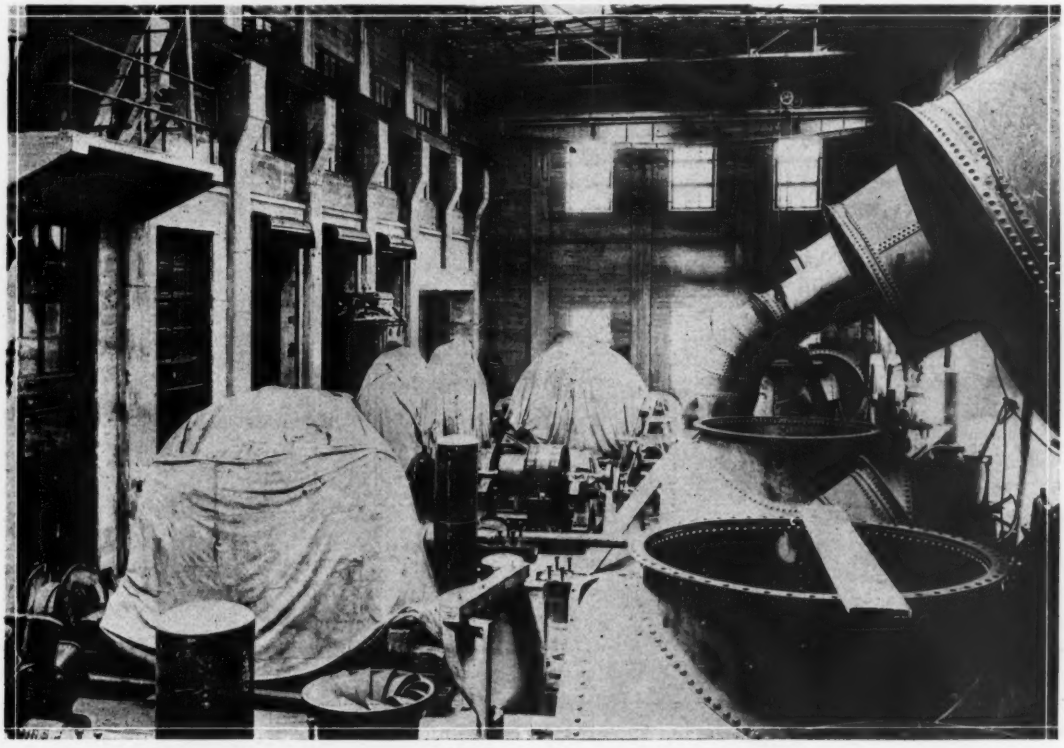


FIG. 11. CONSTRUCTION VIEW IN GENERATOR ROOM

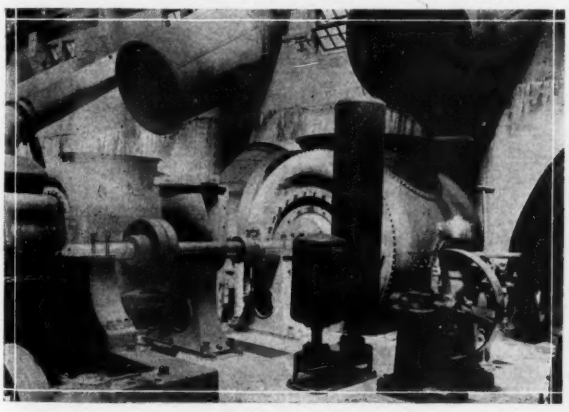


FIG. 12. TURBINE UNIT GOVERNOR AND PUMP

The 2 exciting units are each to generate 1600 amperes at 120 volts and will run at 500 r.p.m. They are to have an efficiency of 90.7 per cent at full load, 90 per cent at 0.75 load, and 88 per cent at 0.5 load, with an overload capacity of 25 per cent for 2 hr. and momentary overload of 50 per cent without serious sparking. Exciter units will furnish current not only for exciting the generators, but also for driving the direct current motors about the plant, for operating gates, pumps, and so forth, and the lighting for the power plant superintendent's house and other buildings.

Exciting current furnished to each generator will be 110 amperes at full generator load or 130 amperes when the generator is furnishing 279 amperes per terminal at a power factor of 0.9.

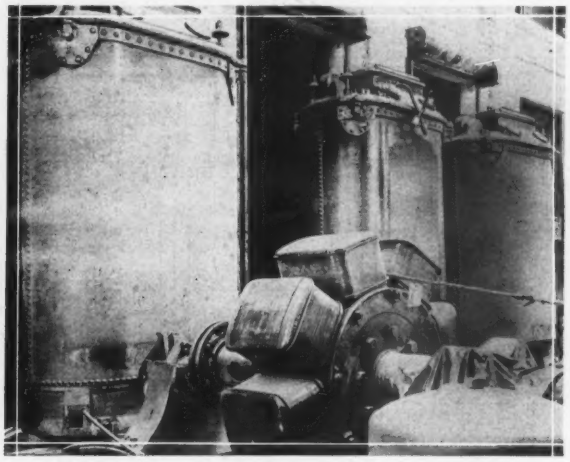


FIG. 13. GENERATOR PARTLY ASSEMBLED AND 3 TRANSFORMERS

Field windings for the main generators are copper strip and are subjected to an insulation test of 1500 volts for 60 sec. The armatures are designed to give a

voltage regulation of 8 per cent at power factor of 1 and 17 per cent with a power factor of 0.9. On noninductive load, main generators will give an efficiency of 96 per cent at full load, 95 per cent at 0.75 load, and 93.5 per cent at 0.5 load. With a power factor of 0.9 the efficiencies are respectively, 95, 94.5 and 93 per cent.

The main generators will stand a 25 per cent overload for 3 hr. with a rise of 50 deg. Cent. in temperature and 100 per cent overload for 5 min.

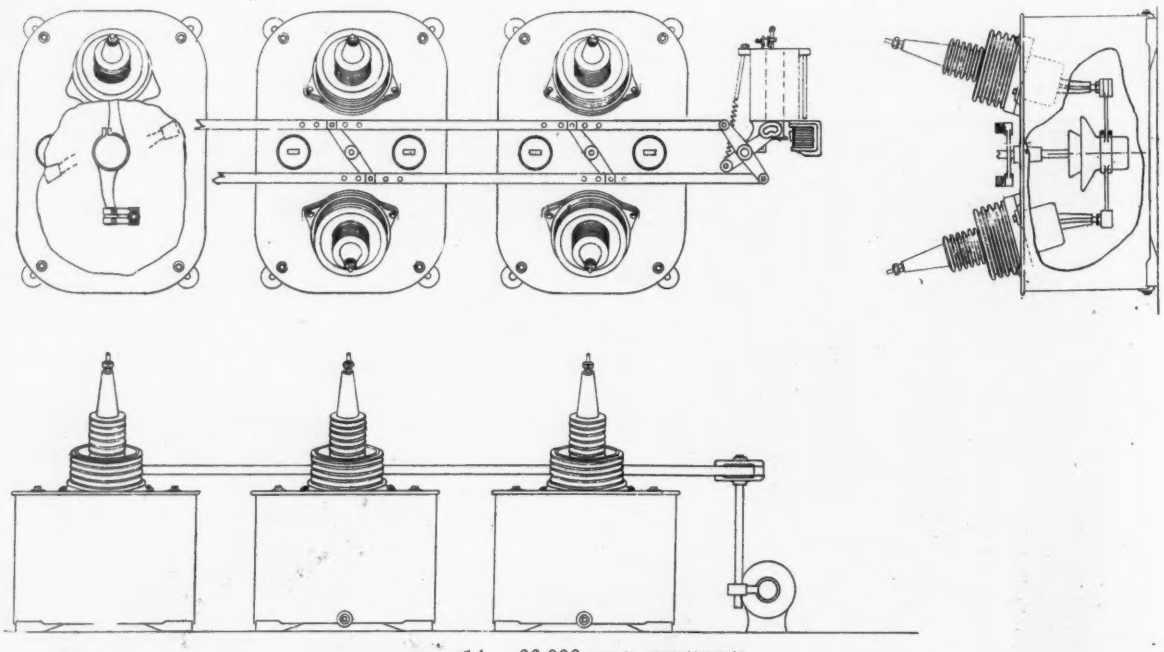


FIG. 14. 66,000-VOLT SWITCHES

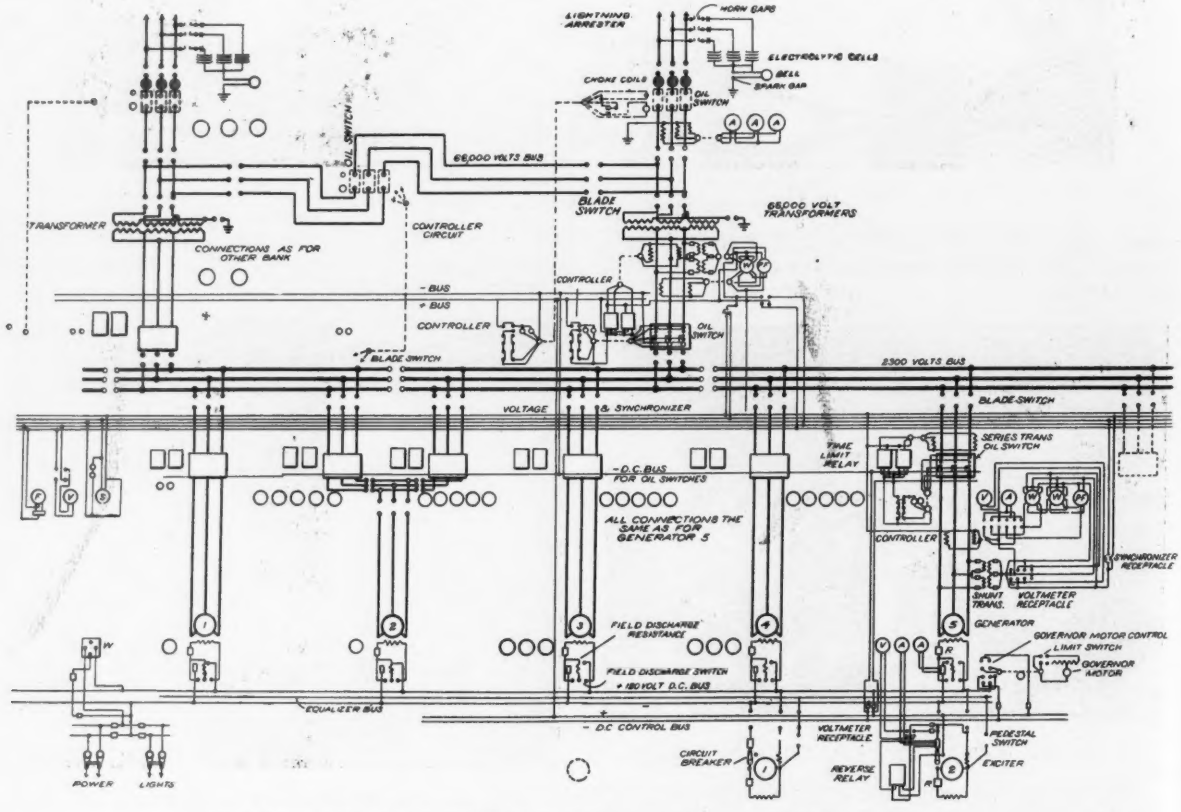


FIG. 15. DIAGRAM OF ELECTRICAL CONNECTIONS OF SWITCHING SYSTEM

Careful attention is paid to the speed regulation of the exciter units as well as the main generators the same method being adopted for governing in both

cases. From maximum load of 1900 hp. to no load, the change being instantaneous, the speed variation on the main units is 10.5 to 12 per cent, while a change of 475 hp. in the load will result in speed change of 2.75 per cent. Exciter regulation will give a change of 16 to 17 per cent with off and on load of 375 hp. and 4.5 for 94 hp. change. The flywheels used for steadying the generator units are 7 ft. 10 in. outside diameter and those on the exciter units are 4 ft. 7 in.

Switching Apparatus

CONNECTION from the generators to the operating switches is by cables, laid in conduits which, as shown in the cross section of the station, pass under the generator foundations and lead to the switchboard side of the power house. The general scheme of connections for the system is shown in the diagram, Fig. 15.

Exciter buses are provided which are mounted on the operating panels running across generator and exciter panels. The regular provision for compound wound machines is made of positive and negative buses, and equalizer, the positive and negative switches being on the panel and the equalizer switch on a pedestal near the exciter.

FIG. 16. ANGLE POLE AT START TRANSMISSION LINE

Voltmeter, ammeter, rheostat control, main switches and circuit breaker constitute the equipment for each exciter panel. From the direct current bus bars are also taken off 6 lighting circuits and 7 power circuits and the control lines which operate motors for the governor regulation and the high pressure switches.

On each generator panel is mounted a rheostat for field control, voltmeter, ammeter, integrating wattmeter, indicating wattmeter, and power-factor meter, provision being made in cells at both sides of the operating panels for the necessary shunt and series instrument transformers.

For 4 of the generators, current after passing through an oil break circuit breaker, and disconnecting switches, goes to the high voltage bus bars. The fifth generator has a double connection because the high voltage bus bars are made up in 2 sections and this machine is arranged to connect to either one of the 2 sections.

Transformers are banked in 2 sets, 3 transformers in each set with a single spare transformer which may be thrown in at any point. These transformers are of the oil insulated, water-cooled type made by the General Electric Co., stepping the generator voltage of 2300 up to the line voltage of 66,000. Each transformer has a capacity of 1000 kw.

Between the transformer bank and the transmission line is located a high tension switch made by the Pacific Electric & Mfg. Co., of San Francisco, these switches being intended to carry 150 amperes at 80,000 volts. The construction is as shown on Fig. 14.

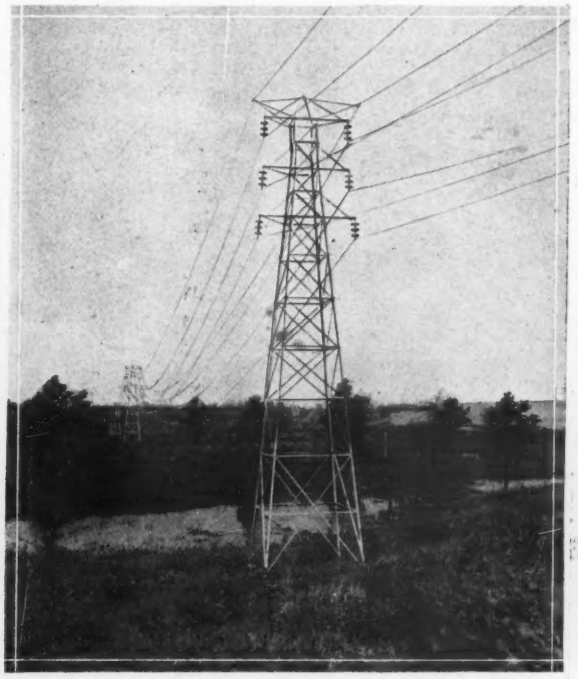


FIG. 17. A SECTION OF THE POLE LINE

Connections have porcelain insulated terminals and the switch blade which is simply a swinging arm is mounted on a porcelain petticoat insulator inside the switch box, and connects into spring clips as indicated. The 3 switches for the 3 phase line are operated by wooden bars connecting to links on the top of the switch box, and these bars are moved by a quick-break mechanism driven by a solenoid.

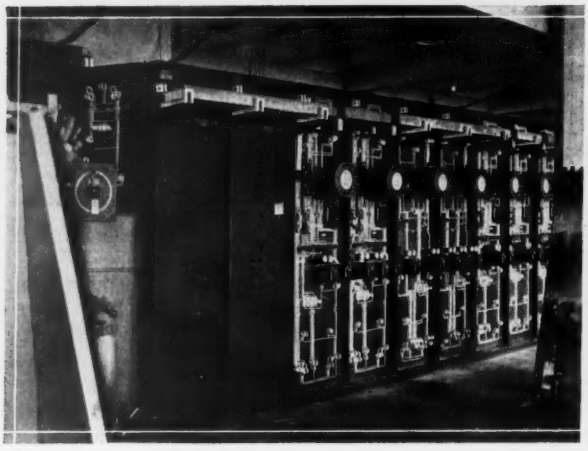
Advantages of this switch are its simplicity and provision of a solid cast-iron box, removable contacts, no wood parts in the oil and the conducting parts supported from the cover. The switch is mounted in the open with no brick or concrete cells required. One of these is provided in each transmission circuit and one in the tie-line between the 2 circuits.

At all points on both high and low-tension work single-pole, single-throw switches are provided for making sure that a line is dead while working on it.

High Voltage System

A FEATURE of the transmission system is that from the high voltage terminals of the transformers to the lightning arrester connections all conductors are of Swedish iron wire, the object being to get a choking effect to prevent lightning discharge from entering the station.

Outside the station where the wires enter from the line, horn gap lightning arresters are provided with electrolytic ground connections. The electrolytic jars are mounted inside the building but the horn gaps are located outside on pipe frame construction and the grounding is made to all the penstocks, turbine cases and other water pipes.



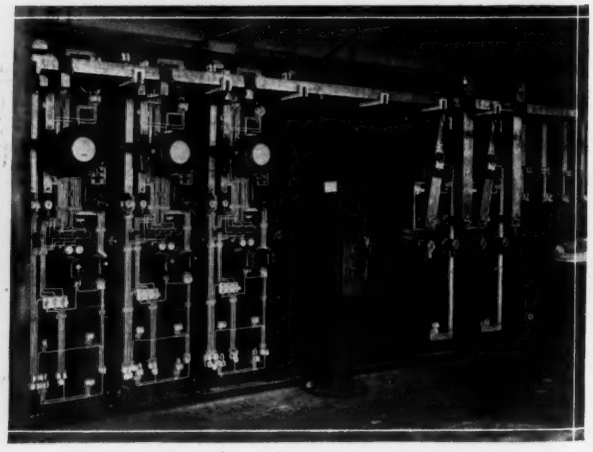


FIG. 18. VIEWS OF HIGH FALLS OPERATING PANELS, FRONT AND REAR

Choke coils are, of course, provided inside the lightning arresters but the iron wire is used as an additional precaution, the copper on the transmission lines being carried only as far as the lightning arrester connection.

Transformers are mounted in concrete compartments, a separate compartment for each one, and piping is arranged so that without moving the transformer the oil can be drawn off and filtered and returned to the transformer or the oil can be drawn off to a storage tank and new oil filled into the transformer at the same time without shutting down or stopping the operation of the apparatus. The storage tanks, filter and pumps for handling the oil system are located on the first floor of the switch house.

Water for cooling the transformers is taken from the penstocks of the exciter units, piped through cooling coils of the transformer and discharged to the tail race.

The instrument transformers for both 2300 and 66,000 volt systems, are located in compartments built up of concrete and have asbestos curtains in front.

Outside the power house, the transmission line crosses the tail race by a span to an angle tower and then strikes due east to the Johnson's Falls station. The towers are of structural steel resting on 4 concrete posts set into the ground. The transmission line is of ⅜-in. stranded copper conductor suspended by strain or hanging insulators as may be necessary to the cross arms, 3 wires of a circuit being carried on one side of the tower. The line runs for 61 miles to Green Bay, towers being spaced at an average of 525 ft. apart, although the distance is varied according to the character of the country traversed.

L. E. Myers & Co., of Chicago, were the contractors for the tower line, H. J. Hunt being the resident engineer on this part of the work. The insulators were furnished by R. Thomas & Co. of E. Liverpool, O. At the Johnson's Falls site the 2 circuits are separated, one being carried above and the other below the Falls and pole top switches are provided in each circuit so that either circuit may be operated from the Johnson's Falls plant alone if desired. The switchboard comprising the main control board, all the instruments, switches, lightning arresters, etc., was furnished by the Westinghouse Electric & Mfg. Co., with the exception of the 66,000-volt switches already mentioned and the field rheostats which were furnished by the Cutler-Hammer Co. These rheostats have a capacity of from 65 to 235 amperes, a resistance of 1.04 ohms and are arranged to carry 120 volts.

In preparation of this article courtesies and assistance were received from President Josslyn, Professor Mead, Resident Engineer Reineking and H. C. Driver and Geo. A. Hathaway of the Westinghouse and Allis-Chalmers Cos.

MOUNTAIN METHODS OF ENGINEERING

By N. Devering

WHILE waiting for a train at a small railroad station in the mountains I got into conversation with one of the natives. Upon learning that I was an engineer, he gave me the following line of talk, and while I am unable to do his grammar and dialect justice, I will give it as closely as I can remember.

"A short spell back Bob Zediker used ter be the ingine man daown to the saw mill, an' a most likely one he were too. Bob used ter keep the ingine greased up, an' done all the slab pokin' under the bawler, as well as a heft on all the big sticks that went through the mill.

"A right smart fellar Bob was 'baout ingines and bawlers; he worked raound them most ever since they begun cuttin' timber outen these yer woods raound yer.

"Naow, Bob tuk suddint sick one day, an' wasn't tall fit ter stay ter work, so Joe Morris, he that owns the saw mill, told me to poke slabs under the bawler an' keep the ingine greased.

"He said he knowed I was the most likely fellar baout there, 'cause I used ter give Bob a hand naow an' then when he were fixin' up baout the ingine an' bawler.

"So I greased the ingine an' poked slabs the rest o' that day all right, all right, an' kep' the steam clock hand a pointin' to the sun the hull afternoon.

"Nex' mornin' I was daown to the mill early an' soon had the steam up, 'cause I poked her good an' full o' them slabs when I got the fire agoin'.

"Then I turned steam on the ingine an' started her agoin'; but, my laws, fellar, she slapped an' banged every time she turned over, just saounded baout like dropping slabs in the water, flat side nex', water seemed ter come out baout every crack an' hole on the pushin' end o' that ingine.

"I never seen the water comin' thru like that when Bob started her, but I got things goin' an' done tol'able well. I kep' my eye close on the bawler, 'cause Bob sed to allus keep lots o' water in her, an' she wouldn't bust up. I kep' loads o' water up in the bawler, all right, all right, an' the ole ingine looked putty much like she was tryin' to run as a water wheel 'sted of a steam ingine. Joe Morris came raound an' sed to open them plugs on the pushin' end o' the ingine an' leave the water out; I did that, an' she didn't squirt so much water raound the sides then. It kep' me mighty busy pokin' slabs from then on, but we got a tol'able big day's cuttin' out that day.

"Nex' mornin' before the men got raound, I hed the steam clock showin' baout 80 pounds, an', all at once, there was a mighty powerful bang, crack, in front o' that bawler, an' a blowin' o' steam an' water, an' jes' seemed like 'twas goin' to fill the hull ravine chock full to top o' the mountains with steam. I tell you, pard, baout that time I was on a trip fer my health, an' I made tracks long the log line baout as fast as Bill Hesker, when the wild cat chased him up Smiley's holler.

"After goin' some I looked raound an' seen the bawler was still there, so I goes back an' snuck in behind her an' opened the blowout valve wide, an' left all the steam an' water outen her, 'cause I knowed if there weren't much steam she couldn't do much harm.

"It made a putty loud fuss blowin' steam an' water clear cross to the far side o' the gully; she soon quit her fussin', an' I got raound to her nose an' seen what all the fuss was baout. Do you know the pesky water-glass pipe hed cracked an' blowed out clean as a bird's nest in December.

"Baout that time Joe Morris an' the boys came up all outer breath, to know what the noise were. Well, the slabs were baout nearly burnt out by that time, so Joe sed to get her agoin' agin, naow I never see Bob fixin' one o' those water-glass pipes, but I weren't goin' to squeal on the job, so I looks raound an' finds one o' them glasses, but the ends were orful loose top an' bottom, an' I knowed that wouldn't do; so I finds some sticky tape like that Bob hed in his tool-box, an' I wraps a lump o' that on each end, an' put it in agin.

"Baout the time I hed 15 pounds o' steam agin, fizz, fr-r-oop, out went the pesky sticky stuff, but this time I didn't leave the water outen the bawler, 'cause I seed 2 valves at the ends o' the water-glass pipe, an' I shuts them, an' reckons I cud fix it agin.

"Ike Hasen, the sawyer, came raound an' sed he seen Bob puttin' gum rings raound them glass pipes 'fore he put 'em in. Not to let Ike know I didn't know haow to fix 'em up all right, I jes sed I couldn't find the rings.

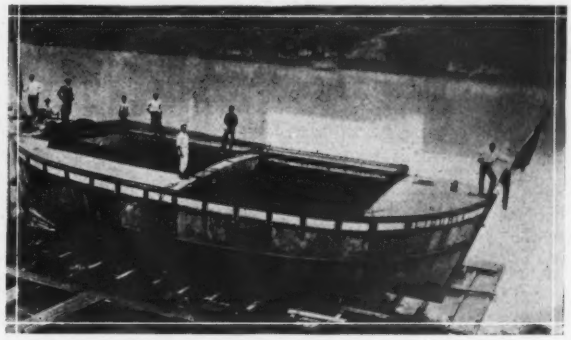
"Ike, he looked in Bob's tool-box, an', by heck, there was a string full o' rings, an' that glass pipe fit in them there rings like a fat 'possum in a holler tree.

"Then I soon hed the bawler fired up agin an' the saw was a singin' once more; but I'll tell you mister, it takes a right smart fellar to tend a ingine an' a bawler, all right, all right."

STONE BOATS

NOT the kind on which our granddaddies hauled stone for walls and foundations, but boats in which to navigate the deep waters. As if it were not enough to make ships of steel and have them float, an Italian firm is now using rocks—reinforced concrete—built with 2 shells and air cells between so that it is nonsinkable.

These are not toys either. They are barges 60 ft. long, 17 ft. beam and 5 ft. deep. The frame is of iron rods and wire netting covered with a wall of concrete 1 in. thick like plastering on lath. Sounds as if it might crack easily in a collision, but the Italian government banged one of them into a bridge pier and rammed it with a tugboat, then ordered 4 more and went on using the one that had been maltreated so there seems to be elasticity in these rock shells.



STONE BARGE UNDER CONSTRUCTION SHOWING CROSS GIRDERS AND REINFORCEMENT

They are smoother than steel or wood, do not collect animal and vegetable growths, do not rust or decay and after 8 yr. use were reported in perfect condition and no repairs.

DETAILS OF POWER PLANT DESIGN

ESTIMATING BOILER CAPACITY REQUIRED

By Charles L. Hubbard

WHILE the average descriptive article of a power and heating installation contains much of general interest, and often considerable valuable detail, it is sometimes difficult to trace out the different parts from the assembled drawings and to understand the reasons for certain arrangements. Again, while the size and make of various parts of the equipment are usually given, the reader is not informed as to the methods employed for computing the sizes, or why certain types of apparatus are best adapted to special conditions. It is the object of this article to take the drawings and specifications of a typical office building power plant, as an illustration, and discuss briefly the different parts, giving simple methods of computation and points to be considered in the selection of various parts of the equipment.

Boilers

IN buildings of this kind boiler power is usually required for heating, ventilation, lighting, hot-water supply, power for the operation of elevators and fan motors, and in some cases for refrigeration.

Heating

BOILER power for heating is usually obtained from the amount of radiating surface to be supplied, and for all practical purposes the following ratios may be used, in which it is assumed that one boiler horsepower will supply 130 sq. ft. of direct cast-iron radiation, 100 sq. ft. of direct wrought-iron pipe coils, 50 sq. ft. of indirect cast-iron radiation. Boiler power computed in this manner should be increased about 5 per cent for losses due to radiation from steam and return mains.

Ventilation

BOILER power required for ventilation is based on the volume of air to be supplied. This may be found by the rule that the horsepower is equal to the cubic feet of air to be warmed per hour from zero to 70 deg., multiplied by 1.3 and divided by 33,000.

Power For Lights

IN finding the boiler power for lighting, we first determine the electrical energy to be supplied at the lamps, then find the indicated horsepower of the engines necessary to produce this, and then compute the probable quantity of steam required from the type of engine to be used.

In computing the approximate electrical horsepower at the lamps the following table may be used.

Number and Type of Lamps Supplied by One Horsepower:

12 16-c.p. incandescent.
6 32-c.p. incandescent.
2.2 half-arc, open.
1.5 full-arc, open.
1 to 1.5 closed arc.

Efficiency of a first-class generating set, including the losses in transmission, may be taken as about 75 per cent when located in or near the building to be lighted, so that the electric horsepower necessary to supply the lamps, divided by 0.75 will give the indicated horsepower of the engines.

The average steam consumption of the types of engines commonly used in this class of work is given in the table.

The total weight of steam required, in pounds per hour, divided by 30, will give the approximate boiler horsepower.

Driving Fans

POWER for driving the fan motors may be included with the power for lighting, by assuming one horsepower of electrical energy delivered to the motors for each 2000 cu. ft. of air to be moved by the fans per hour.

Hot Water

THE boiler power for hot-water heating may be determined by multiplying the number of gallons of water to be heated per hour by the increase in temperature and by 8.3, then divide by 33,000 to reduce to horsepower.* The temperature increase may be taken as 140 degrees under average conditions.

Elevators

THE horsepower required for raising an elevator is found by multiplying the sum of the live load, which averages about 70 lb. per square foot of floor space in the car, and the unbalanced weight of car, which may be

STEAM CONSUMPTION OF ENGINES

TYPE OF ENGINE	POUND OF STEAM PER I.H.P. PER HR.	
	NON-CONDENSING	CONDENSING
SIMPLE—HIGH SPEED	30 TO 34	22 TO 26
" MEDIUM "	28 " 32	21 " 25
COMPOUND HIGH "	24 " 28	18 " 22
" MEDIUM "	23 " 27	17 " 21

taken as approximately 25 lb. per square foot of floor space in hydraulic elevators, and 0 for drum and duplex electric elevators, by the speed in feet per minute, average 400, divide this product by the efficiency, average about 0.6, and divide again by 33,000 to reduce to horsepower.†

Allowing for stops and time when the elevators are idle, it is customary to consider that each elevator is in operation 0.7 of the time. As hydraulic elevators are not counterweighted up to their full weight, they descend by gravity, so power is required only on the upward trip.

The above rule is for a continuous upward movement, hence, if the elevator is in operation only 0.7 of the time, and one-half the time that it is in actual operation is occupied in downward trips, requiring no power, the results found by the above calculation should be multiplied by 0.7 times 0.5 when considering a hydraulic elevator. Substituting the average values as given above we find the required horsepower for each square foot of floor space in the car to be $\frac{(70+25)\times 400\times 0.7\times 0.5}{0.6\times 33{,}000} =$ 0.7. Hence, the total square feet floor area of the eleva-

*Expressed as a formula this becomes:

$$\text{hp.} = \frac{G \times 8.3 \times (T_2 - T_1)}{33{,}000} \text{ in which}$$

G = gallons of water to be heated per hour
T_1 = initial temperature
T_2 = final temperature

†The formula for this calculation is:

$$\text{hp.} = \frac{(W + w) \times S}{E \times 33{,}000} \text{ in which}$$

W = live weight
w = unbalanced weight of the car
S = speed
E = efficiency

tor cars multiplied by 0.7 will give the horsepower to be delivered by the pumps.

The necessary boiler power will depend upon the type of pump used. The following table gives the average steam consumption in pounds per delivered horsepower per hour for different types of duplex pumps.

Type of Pump	Rate of Steam Consumption. lb. per hp.-hr.
Simple Noncondensing	120
Compound Noncondensing	65
Triple Noncondensing	40
High-duty Noncondensing	30

The total horsepower required, multiplied by the rate of steam consumption, divided by 30 will give the boiler horsepower.

Electric elevators of the drum and duplex types are commonly overweighted to the extent of 40 to 50 per cent of the maximum live load. From this it is evident that with no load the power required to pull the car down is that necessary to raise the counterweight, which is equal to one-half the live load, and to overcome the friction of the machine.

When the car is half full, it is balanced, and the power required is that due to friction only. At full load the conditions are the same as for an empty car, except that power is required for both the upward and downward trips, instead of the downward only. If the full load were carried on both upward and downward trips, or sufficient of it on the downward trip to overbalance the counterweight and the friction of the car, the conditions would be the same as in case of the hydraulic elevator; that is, power would be required only on the upward trip. This condition, however, does not hold, especially in the case of office buildings, where, during the morning hours, the maximum loads are on the upward trips, with empty, or nearly empty, cars coming down. Under these conditions the power is practically the same on both trips, owing to the necessity of raising the counterweight when the car is descending. This makes it necessary to treat the problem the same as if the machine were raising a continuous load.

The rule for an electric elevator of the types described, therefore, is to multiply the live weight by the speed and by 0.7, and divide the product by the efficiency times 33,000; by substituting average values for the known quantities as before, we find the horsepower for each square foot of floor surface in the cars to be

$$\frac{70\times400\times0.7}{0.6\times33{,}000}=1 \text{ approximately.}$$

Assuming a combined efficiency of 0.65 for the engine, generator, and motor, the indicated horsepower of engine per square foot of floor surface in the cars must be $1\div0.65=1.53$, and this multiplied by the total floor space, in square feet, will give the total indicated horsepower of the engines. From this point on the method of obtaining the boiler horsepower is the same as already described in the case of electric lighting. The power for operating electric elevators of the screw type is determined the same as for a hydraulic elevator, except that an efficiency of 0.7 is used instead of 0.6. After the actual power for operating the elevator is obtained the boiler power may be found the same as for the other types of electric elevators just described.

Refrigeration

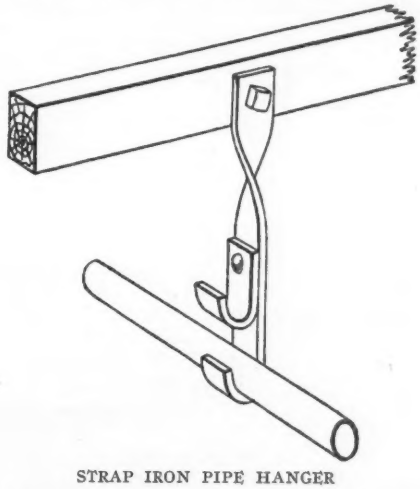
CAPACITY of a refrigerating plant is commonly expressed in 2 ways; "ice-melting effect" and "ice making." For example—a 20-ton machine will produce the same cooling effect in 24 hr. as the melting of 20 tons of ice, or in other words, will extract the same amount of heat from the brine as would be required to melt 20 tons of ice into water at a temperature of 32 deg.

Theoretically, the extraction of this amount of heat from 20 tons of water, at an initial temperature of 32 deg., should change it into ice; but in practice there are various losses not present in the simple process of cooling, so that it is customary to allow for twice the boiler power per ton for ice making as for the process of cooling or ice-melting effect. The indicated horsepower required per ton of refrigeration depends upon the suction and condenser pressures, which in turn are governed by the temperature and amount of the condensing water used.

Under conditions where condensing water must be obtained at average city prices the most economical results are obtained with suction pressures ranging from 20 to 30 lb., and condenser pressures of 140 to 150 lb. Under these conditions one indicated horsepower in the steam cylinder will produce about 60 lb. of ice-melting effect per hour, or 0.75 ton per 24 hr. This will, of course, vary somewhat with the range of pressures and also with the size and type of machine, but in the absence of more exact data, may be used for approximate results. Another method in common use is to provide 1.5 indicated horsepower per ton of refrigeration, which is slightly more than the previous case. Knowing the indicated horsepower of the compressor, the probable steam consumption can be determined for that particular type from the table already given for steam engines, and the boiler horsepower computed from this the same as already described for electric lighting.

A SIMPLE PIPE HANGER

THIS hanger consists of 2 or more small hangers, riveted together in such a manner as to form hooks at the required distance from each other. The hangers are made of wrought iron, about ½ in. thick and 2 in. wide. The iron can be heated first and bent around a pipe of the same diameter as that which is to be



STRAP IRON PIPE HANGER

used, which will prevent the pipe from vibrating after it is hung. If the pipes are to run in opposite directions, or to the beams above them, the iron can be heated and twisted to the right angle. The upper end is drilled to receive a ½-in. lag screw, by which the hanger is fastened to the beam.—Popular Mechanics.

BUSY YOURSELF with the important things of life; there is not time for others.

LONDON LETTER

A NEW SEMI-STATIONARY COMPOUND ENGINE

By W. A. Tookey

AS a result of the competition between gas and steam power, now keen in all parts of the world, British engineers, who have hitherto confined their attentions to the manufacture of steam engines, have either already undertaken the construction of gas engines, or are engaged in preparing designs or negotiating with firms already well established for license to manufacture patented engines. Some, however, still cling to the steam engine, knowing that not only will there always be a good market for such reliable machines, but that, even on the basis of economy the gas power plant is not, after all, so extremely efficient as those engaged in its manufacture would have us believe.

There is much to be said from this point of view. Acting in a professional capacity, I have had many opportunities of noting the actual performances of steam and of gas power installations as recorded in engine room log books, over extended periods, and taking into account all the little incidental items which do not appear in professional tests, but which seriously affect the fuel bill under actual service conditions.

Speaking generally, I have found that the average consumption of good anthracite, including stand-by losses amounts to 1½ lb. a b.hp., as checked by electric meters (2 lb. a kw.) for gas engines served by suction gas producers. This rate of consumption is practically independent of the size of unit. Similarly from a log kept for over 5 yr. of a large plant comprising 4 250-hp. engines fed with gas from a pressure-producer plant, burning bituminous coal, working 144 hours a week at 90 per cent of rated full load output, the average consumption has amounted to 3 lb. a kw., or 2¼ lb. a b.hp. hr. These figures are for the coal as fired, and no fancy deductions or approximate corrections have been made.

Steam engine builders then, have not a very difficult task to equal such figures as these, and a British firm, Richard Garrett & Sons, Limited, claims that it has been successful in equalling if not surpassing the performances of gas engines with its latest type of semi-stationary compound engine, using superheated steam. The combination of boiler and engine presents many novel features, and the more interesting of these it is now proposed to describe.

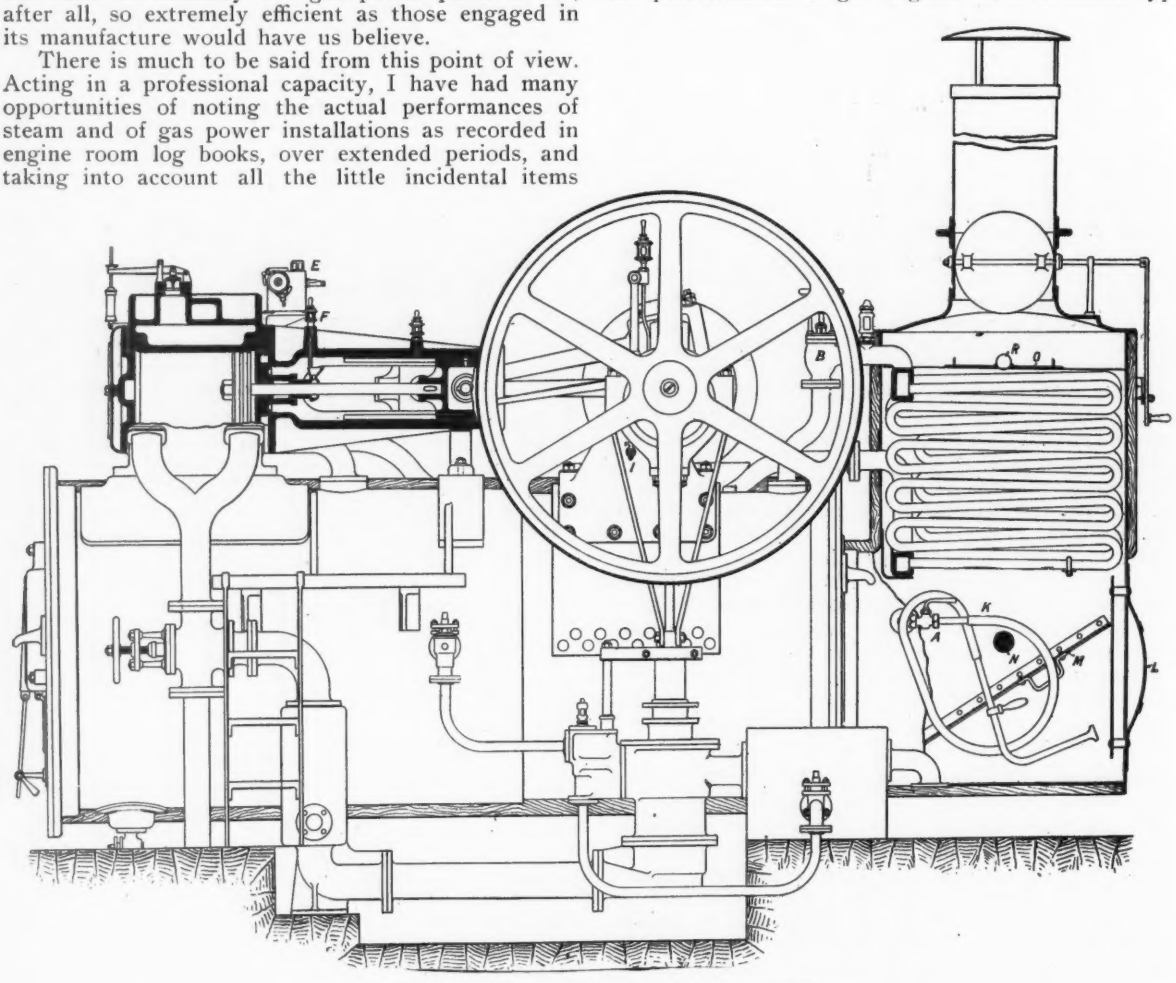


FIG. 1. SEMI-STATIONARY COMPOUND ENGINE

Boiler

STEAM is generated in a multitubular cylindrical boiler, of which the furnace and tubes can be withdrawn for scaling, inspection, and renewal. The front plate of the boiler, carrying the fire door and fittings,

is bolted to the shell and to the flanged-out, circular fire-box end plate, and at the smoke-box end, a joint is made between the smoke-box tube plate and the plain shell end plate, by means of angle rings. Longitudinal angle-iron guide bars are placed in the lower part of the boiler to guide the back tube plate during the withdrawal of the interior parts.

The shell of the boiler is made of special mild-steel plates, each section being one entire piece, needing but one double riveted butt joint in its circumference, with double cover plates. The angles at the end of the shell are solid rolled rings, shrunk on before riveting.

The furnace is of special corrugated type, rolled and flanged in one piece. The tubes are of solid drawn steel and are expanded into back and front tube plates, a certain number being threaded, as well as expanded, to act as stays. The spacing is arranged sufficiently to permit a scaling chisel to be used to the innermost tube. Three cast-iron pedestals, placed respectively at the front, under the crank, and below the smoke box, are provided for supporting the boiler, the combined weight of the unit being such as to require little or no special foundations. Above the fire box end of the shell, a pressed steel saddle piece is placed to which the engine casing is bolted. The main bearings are supported by pressed steel brackets, riveted to the shell, and have 2 facings, each at right angles to the other, to combine rigidity with perfect alinement.

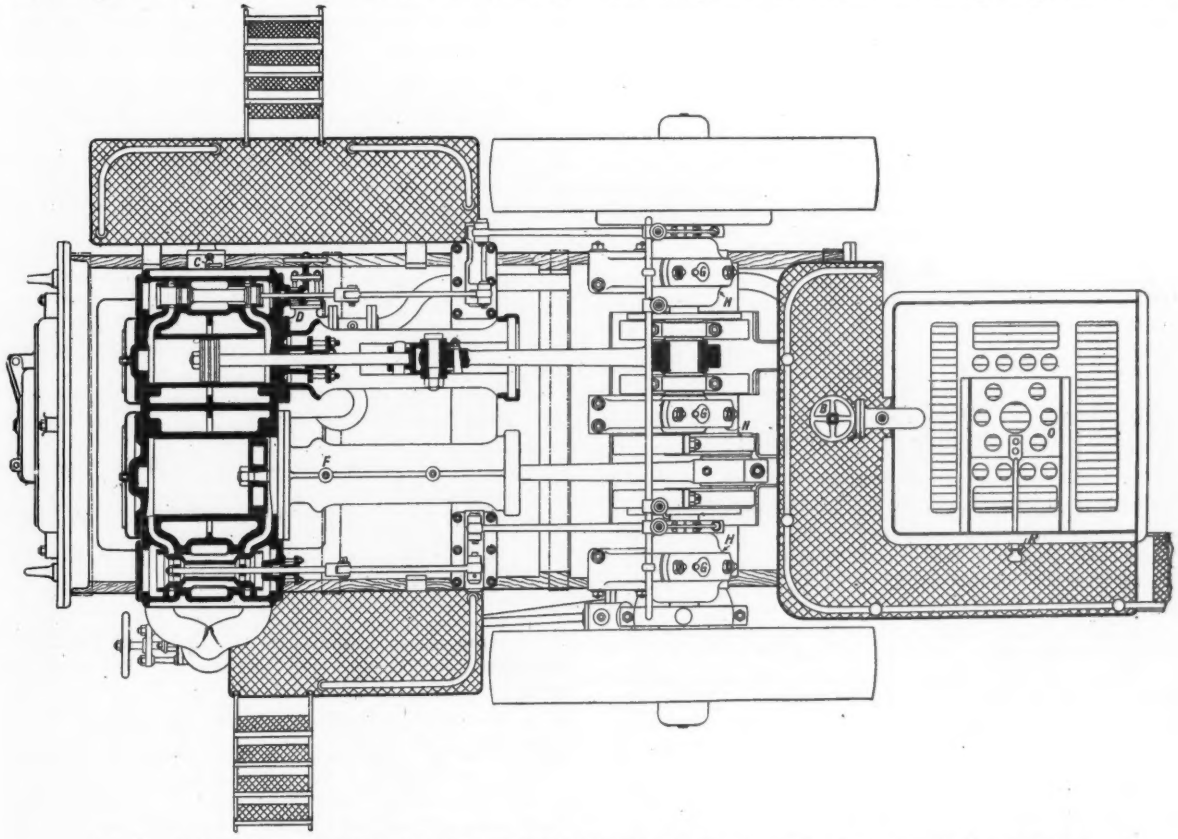


FIG. 2. HORIZONTAL SECTION OF SEMI-STATIONARY COMPOUND ENGINE THROUGH THE CYLINDERS

Superheater

IN order to avoid interference with the ready access for tube cleaning, the superheater is arranged in a vertical extension of the smoke box. It consists of 2 solid steel headers, connected by tubes arranged in zig-zag fashion and staggered so as to ensure maximum efficiency as regards exposed area. The saturated steam enters the upper header, and passes out in a highly superheated state at the bottom, which is in contact with the hottest gases passing from the tubes. A baffle plate is provided immediately above the superheater to increase its efficiency by causing greater diffusion of the escaping gases, it being found that without such provision, the heat transmission was reduced owing to the gases passing directly through the central portion of the nest of tubes.

All joints connecting the superheater with the main steam pipe are external, so that they do not get sooted up, and the further advantage is gained of having everything under easy supervision for the ready detection of leaks as well as for dismantling. In the cast-steel headers, a screw plug is placed opposite the end of each tube, making the replacement of the latter a simple operation. The superheater also has its own stop valve and relief valve, so that it can be completely and safely isolated from the boiler when it is so desired.

Engine

TWO cylinders are placed side by side above the fire box end of the boiler, and connected through crossheads to separate cranks, at 90 degrees, fitted with balance weights. The main cylinder casing surrounds the high and low-pressure cylinder and piston valve liners, which are plain cylindrical castings machined all over and forced in the casings by hydraulic pressure. The space between the liners and the outer casing forms a live-steam jacket, to which the steam is led by an external pipe, thus avoiding troublesome

joints. The main boiler safety valve is connected with the jacket, the pipe connection being of suitable area to pass the blow-off steam. The water produced by steam condensation within the jackets drains directly into the boiler, thus avoiding loss of heat.

Governing is effected by means of a powerful shaft governor, operating the high pressure eccentrics and varying the cutoff. The steam being highly superheated, there is little or no cylinder condensation, so that governing by expansion is the most economical method.

The main bearings of engines of similar type to that under notice are usually tied to the cylinders, but are permitted to have a certain amount of end play on the boiler. Richard Garratt & Sons Ld. consider this bad practice, because the stability of the whole engine is greatly reduced. They prefer to attach both cylinders and bearings to the boiler shell, and obtain perfect alinement when running, by lining up the engines when under running conditions, that is, with steam in the boiler. The method of securing the bearing supports to the shell has already been explained. Lubrication is effected by an endless chain rotating with the shaft and dipping into an oil well formed in the pedestal casting.

Air Pump

THE air pump is driven by an eccentric from the crank shaft and is of the bucket type with a trunk piston rod to form a guide to the bucket. The feed pump is bolted to the air pump casing, the plunger being attached by a bracket to the air pump rod with which it moves. The feed pump draws from the hot well at the opposite side of the air pump.

Performance

UNDER the observation of a consulting engineer, one of these engines rated at 50 b.hp. has recently been tested over a continuous period of 7 hr. from a flying start. Summarizing the full report, it may be stated that the total fuel consumption at an output of 54.63 b. hp. (British) was at the rate of 1.21 lb. of Welsh steam coal of 14,260 B. t. u. a lb.

The weight of water evaporated an hour was 591 lb., the steam being at 178 lb. gage pressure. The temperature of the steam entering the superheater was 378.5 deg. F., and at the engine cylinder, 536 deg. F. The absolute pressure of the steam at the outlet of the engine was 2.87 lb. per sq. in., corresponding to a temperature of 140 deg. F.

The thermal efficiency of the engine on the basis of indicated horsepower was 21.3 per cent, and of the combination 15.46 per cent.

Such results must be admitted to be particularly good, even for engines using superheated steam. The makers point out that the reason for the excellent economy is due to (a) the engine being mounted upon the boiler and consequent avoidance of long steam connections; (b) the condensation from the cylinder jackets being returned directly to the boiler; (c) the careful proportioning of the grate area, boiler, and superheating surfaces; (d) the high standard of workmanship and the use of perfectly balanced piston valves.

WIRE ROPE needs lubrication to protect it from wear on pulleys and guides and also to prevent internal chafing between strands. Such lubrication gives easier bending so that less power is taken up in running the rope, and prolongs the life of the rope. Grease and graphite make an excellent lubricant for this purpose.

DIAGRAM FOR EFFICIENCY OF RIVETED JOINTS

By J. P. MORRISON

THIS chart is based upon a tensile strength of 60,000 lb. per sectional square inch for steel plates, and a shearing strength of 40,000 lb. per sectional square inch for steel rivets in single shear. Rivets in double shear are considered as having 180 per cent the strength of rivets in single shear. The efficiency of the net section would not be changed if sheets of 55,000 or 65,000 lb. tensile strength were used, or if rivets having an ultimate shearing strength of 42,000 lb. were used, but changing the tensile strength of the steel or the shearing strength of the rivets would change the efficiency of the rivets as compared with the strength of the solid plate.

If steel of 65,000 lb. tensile strength was used, the efficiency of the rivets would decrease by 8 1-3 per cent; or if steel of 55,000 lb. tensile strength was used, the efficiency of the rivets would be increased by 8 1-3 per cent. Should rivets of 42,000 lb. shearing strength be used, the efficiency of the rivets will be increased by 5 per cent.

Changing strength of steel or rivets does not affect the efficiency of the net section, but increasing the strength of the plate steel cuts down the rivet efficiency in direct proportion, and increasing the strength of the rivet iron adds to the rivet efficiency in the same proportion.

The efficiency of the rivets gets less in proportion as the thickness of the steel increases and also as the pitch or distance between rivets increases.

For the net section of plate at any pitch there are 2 relations as follows:*

Efficiency of Net Section=(efficiency for twice pitch)×2—100;

or=$\dfrac{\text{(efficiency for half pitch) plus 100}}{2}$

Bearing these simple rules in mind, with the aid of the chart the reader will be able to determine the efficiency of any riveted joint.

Example 1

WE have a boiler constructed of steel of 60,000 lb. tensile strength ½ in. thick. The horizontal seam is double riveted lap. The rivets are 1 in. in diameter, the rivet holes 1 1-16 in. diameter, and the pitch of rivets 3.5 in.; find the efficiency of the joint.

The first step is to locate the pitch of the rivets on the left-hand scale, marked greatest pitch. We find that 3.5 in. is not given on this scale, so we will take double the pitch, bearing in mind that the efficiency of the rivets varies inversely as the pitch. So the efficiency found using 7 in. pitch will be 0.5 the actual efficiency. From the 7-in. mark on the greatest pitch scale, follow the horizontal line to the left until the line representing the diameter of the rivet hole is met. This line is, in this case, the one marked 1 1-16 in.

From where we strike the rivet hole line, proceed downward until the diagonal line representing the thickness of the shell plates is reached. This is the ½-in. line. From this point go horizontally to the right until the line

*In equation form, if E = efficiency of net section at pitch p, E_1 = efficiency of net section at pitch = $2p$ and E_2 = efficiency of net section at pitch = $\frac{p}{2}$

$$E = 2E_1 - 100$$

$$\text{or} = \frac{E_2 + 100}{2}$$

marked double-riveted lap is met, going upward from this point and touching the efficiency of rivets scale at 33.75 per cent. Doubling this efficiency, as has been stated above, we find a rivet efficiency of 67.5 per cent. Follow the horizontal line to the right until the line representing the diameter of rivet hole is met; from this point go downward, meeting the efficiency of net section scale at the division 69.5 per cent. This is the efficiency of

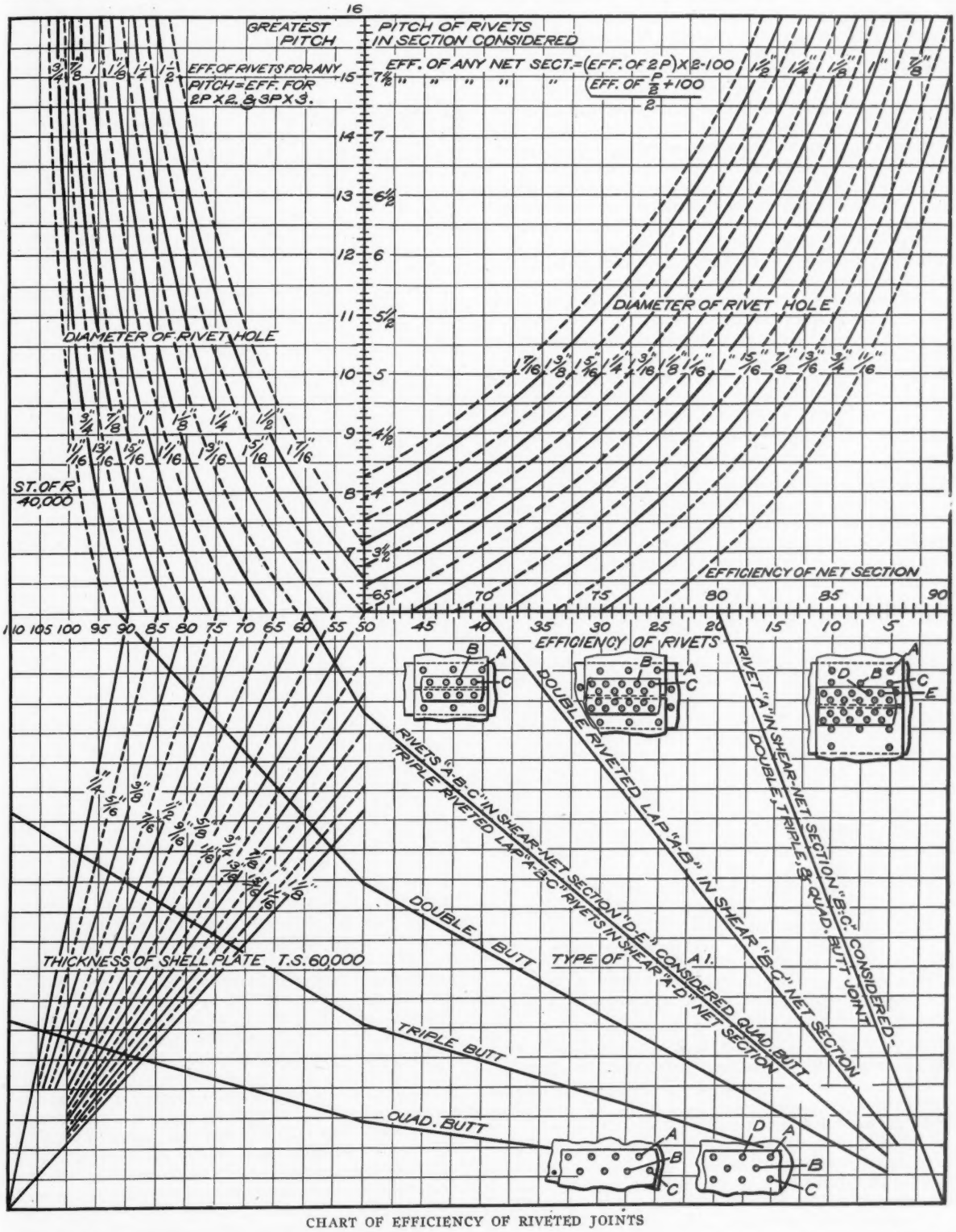

GREATEST PITCH
PITCH OF RIVETS IN SECTION CONSIDERED
EFF. OF RIVETS FOR ANY PITCH = EFF. FOR 2P X 2, & 3P X 3.
EFF. OF ANY NET SECT. = (EFF. OF 2P) X 2 - 100
(EFF. OF P/2 + 100) / 2
DIAMETER OF RIVET HOLE
ST. OF R 40,000
EFFICIENCY OF NET SECTION
EFFICIENCY OF RIVETS
THICKNESS OF SHELL PLATE T.S. 60,000
DOUBLE BUTT
TRIPLE BUTT
QUAD. BUTT
TYPE OF A 1.
RIVETS "A-B-C" IN SHEAR-NET SECTION "D-E" CONSIDERED QUAD. BUTT
TRIPLE RIVETED LAP "A-B-C" RIVETS IN SHEAR "A-D" NET SECTION
DOUBLE RIVETED LAP "A-B" IN SHEAR "B-C" NET SECTION
RIVET "A" IN SHEAR-NET SECTION "B-C" CONSIDERED-DOUBLE-TRIPLE & QUAD. BUTT JOINT

CHART OF EFFICIENCY OF RIVETED JOINTS

We will next consider the net section. Locate 3.5 in. on the scale marked pitch of rivets in section considered. the net section as compared with 67.5 per cent for the rivet shear.

If in the boiler considered above the steel had been of 55,000 lb. tensile strength, the efficiency of the rivets would be increased by 8 1/3 per cent of the efficiency, 67.5×0.08 1/3, which is 5.6 per cent of the solid plate, making an efficiency of 67.5+5.6=73 per cent. But should the tensile strength of the steel be increased to 65,000 lb., the efficiency of the rivets in shear will be increased to 62 per cent.

Example 2

CONSIDER the same boiler plate as in the previous example, but assume a triple riveted lap seam, using ⅞-in. rivets, 15-16-in. holes and pitch the center 3.5 in. as in the previous example.

We proceed as before by taking 7 in. as the pitch. Go toward the left along the horizontal line, meeting the 15-16-in. diameter of rivet-hole line, then downward, meeting the ½-in. plate line, then to the right to the line marked triple-riveted lap, then up to the efficiency scale, which we touch at 39.5 per cent. This efficiency we double, on account of doubling the pitch, and have an actual rivet efficiency of 79 per cent.

The net section is found, as previously explained by going from the rivet-pitch scale to the right, meeting the 15-16-in. line, and then going downward to the scale marked efficiency of net section, which we strike at the 73 per cent mark, which, being the smaller efficiency, would determine the strength of the seam.

Example 3

WE will next consider a triple-riveted butt joint: Rivets, ⅞-in. diameter; rivet holes, 15-16-in. diameter; pitch of rivets, 7 in.; thickness of shell plate, 7-16 in.; tensile strength of steel, 60,000 lb.

From the 7-in. division on the pitch scale, pass horizontally toward the left to the line representing 15-16-in. diameter of rivet hole, then downward to the 7-16-in. plate line. From this point we should pass toward the right, but it will be seen that the line marked triple-riveted butt passes under the point where the plate line is met, so it will be necessary to go toward the left. Our rivet-efficiency scale, however, is graduated to but 110 per cent, and we find that by going horizontally to the left we do not touch our triple-riveted butt line within the limits of the chart, so our rivet efficiency is greater than 110 per cent of the solid plate, and it will not be necessary to know the exact efficiency.

The efficiency of the net section is found, as previously explained, by locating the 7-in. division of the right-hand scale. From this point we pass to the right until the 15-16-in. diameter of rivet hole line is met, then downward to the net section-efficiency scale, where we find 86.5 per cent, which is the smallest efficiency and determines the strength of the seam.

We find the efficiency of quadruple-riveted butt joints in very much the same manner as we find the efficiency of the triple-riveted butt joint. Excepting when we find the efficiency of the net section, one of our formulas must be used.

Example 4

WE will find the efficiency of a quadruple-riveted butt joint: The shell plate ⅜ in. thick, of 60,000 lb. tensile strength, diameter of rivets ¾ in., of rivet holes 13-16 in., and pitch of rivets 14 in.

We find the same condition exists as with the triple-riveted butt joint regarding the efficiency of the rivet shear. The efficiency is greater than the 110 per cent of the strength of the solid plate, so the line representing quadruple-riveted butt joints is not met within the limits of the chart.

Had we taken 7-16 in. as the thickness of the shell plate, the efficiency of the rivets would have been but 100 per cent, and had the thickness been taken as ½ in., the rivet efficiency would have been found by passing to right from the point where the plate line is met, and the quadruple-riveted butt line would have been crossed, and, passing up the vertical line to the rivet-efficiency scale, 87.5 per cent will be found to be the efficiency of the rivets.

But to return to the consideration of the ⅜-in. plate quadruple butt joint problem, we have found that the efficiency of the rivets is more than 110 per cent of the strength of the solid plate.

We will next find the efficiency of the net section. The pitch, 14 in., is not given on the scale marked pitch of rivets in section considered, so we will take ½ the pitch, or 7 in., and pass horizontally until the diameter of rivet-hole line is met, then downward to the efficiency of net-section scale, which we touch at about 88.5 per cent.

We have taken one-half the pitch instead of the actual pitch, so, remembering our rule, we have $\frac{88.5+100}{2}$=94.25 per cent, the smaller efficiency of the quadruple butt joint just considered.

Special Cases

THE efficiency of a quadruple butt joint as found above may be taken as the smallest efficiency, so long as the diameter of the rivet hole is double the thickness of the shell plate, but when very thick plates are used, it is not practical to use rivet holes of a diameter twice the thickness of the steel, and other modes of failure have to be considered.

For example, consider a case where ¾-in. shell plates, 1⅛-in. rivets, 1 3-16-in. diameter rivet holes, a pitch of 15.5 in., and a quadruple butt joint are used. We find the efficiency of the rivets to be slightly greater than 110 per cent of the strength of the solid plate, and the efficiency of the net section along the line of the outer row of rivets to be 92 per cent of the strength of the solid plate.

Now we will determine the efficiency of the joint, considering the strength of the rivet A in shear, and the strength of the net section B-C (see the drawing of the quadruple-riveted butt joint on the chart).

First, find the efficiency of the rivet A by locating the pitch of the rivets on left-hand scale and following the method explained, until the thickness of plate line is met. From this point follow the horizontal line until the diagonal line marked rivet A in shear-net section B-C considered is met. Then pass up the vertical line to the rivet-efficiency scale, which we touch at 6.5 per cent. This is the efficiency of the rivet A in shear, to which we add the efficiency of the net section along the line B-C. The pitch of rivets along this line is 7.75 in., and the efficiency of the net section is found to be 84.75 per cent, making a total efficiency of 6.5+84.75=91 per cent.

We will next determine the efficiency of rivets A-B-C in shear and net section D-C. Find the efficiency of the rivets in same manner as used in the preceding case, except that we pass vertically toward the rivet-efficiency scale from the point where the diagonal line marked rivets A-B-C in shear-net section D-E considered is met. We reach the rivet-efficiency scale at the 19.5 per cent division. The pitch of the rivets along the line D-C is 3⅞ in., and we find the efficiency of the net section to be nearly 69.5 per cent. To this is added the 19.5 per cent efficiency of the rivets A-B-C, making a total efficiency of 89 per cent, nearly, for this mode

of failure. We have found that the efficiency of the rivets in shear in this joint is over 110 per cent; that the efficiency of the net section, along the outer row of rivets, is 92 per cent; that the efficiency of rivet A in shear and net section B-C is 91 per cent; and that the efficiency of rivets A-B-C in shear and net section D-E is but 89 per cent. The latter efficiency being the smallest, determines the strength of the joint.—Boiler Maker.

ECONOMY OF STEAM POWER

MAKING the fullest possible use of an existing steam plant before branching out into gas engines, or purchasing electric current, will be admitted as a sound economic principle, yet in many cases when the use of steam for power purposes is the sound solution of a problem, it often requires the engineer specialist to discover it. A case that is worth noting, because it was an instance of steam on one side and a choice of gas or purchased current on the other, is that recently reported on to a client by F. W. Dean, of Boston.

The Elements of the Problem

HEATING of the hotel and warming of the hot water supply were done by a steam plant consisting of 2 Babcock & Wilcox boilers, of 127 and 78 hp., respectively. For the water heating, there was a steel tank provided with a thermostatic valve which maintained a uniform temperature; there were also the necessary feed pumps. The condensation in the steam heating system was returned and used again in the boilers.

Power was required to run 3 elevators, 2 passenger and 1 freight; and 3 small motors for operating laundry and other machinery. The necessary electric current was purchased, and came in over 3 wires, 2 of these carrying 220 volts each, for power, and the third having 110 volts, for lighting.

The problem was to provide a new supply of electricity at an annual outlay considerably less than $8200, which was the yearly cost of the purchased current. The only scheme open was to install generators in the hotel, operating them either by steam or gas; and the specific questions were what generators were needed, whether steam or gas was the cheaper motive power under the conditions, and whether either system would be cheaper than the purchased current.

Current Requirement

AS to the generators, the requirement was that they should be able to carry the lighting load, start 2 of the elevators simultaneously, and operate the small motors. There were about 1800 16-cp. lamps in the house, and the maximum lighting load, as settled by general hotel practice, was that required to operate 900 lamps at one time, calling for 50 kw.

Tests of the power required for the elevators and motors showed that starting the 2 passenger cars took 50 hp., and the 3 small motors 6 hp. It was decided to depend on the overload capacity of the generators for the comparatively rare instances when all 3 elevators would be started simultaneously. Hourly readings of the meters showed that the theoretical allowance for lighting power was ample. The maximum electric power required was therefore: For lighting, 50 kw.; starting 2 elevators 50 hp., 38 kw.; operating 3 motors, 6 kw.; total, 94 kw.

A 100-kw. generator, in duplicate, with a 35-kw. generator for use from midnight to some early hour in the forenoon, were recommended. The cost of a gas plant was estimated at a total of $27,400, this including $20,950 for 3 engines, and covering excavating, foundation work, piping, wiring, switchboard and incidentals. The annual cost of operation of gas engines was estimated at $9286, of which $4504 was required for gas used for power, and $3562 for fixed charges on the cost of the engine installation.

Three steam engines were estimated to cost $8408, the total expense of the engines, foundation, wiring, etc., being set at $13,500.

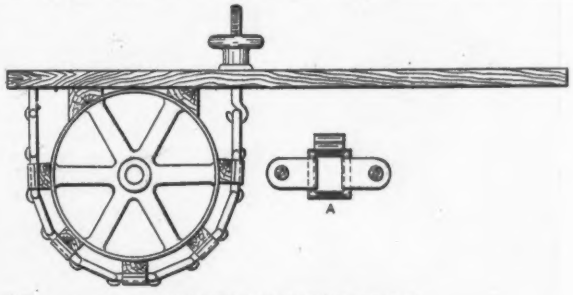
The boiler plant and accessories ample in capacity for these engines, was already operating in the hotel. It was estimated that during 8 months of the year the whole of the exhaust steam from steam engines could be used for heating feed water, wash water, and radiators, and that the engines would be chargeable with consuming 2 lb. of coal per kilowatt-hour when the exhaust was so utilized; and 7.3 lb. per kilowatt-hour in the 4 months when the exhaust was not so used. On the basis of an estimated annual total of 197,586-kw.-hr., the annual coal consumption for the engines would be 372 tons, costing, at $4.34 a ton, $1614. The annual cost of steam power operation was set at a total of $4539, which included $1614 for coal, and $1755 for fixed charges. Comparative costs were summarized as follows:

Cost of installing gas engines.....	$27,400
Cost of installing steam engines.....	13,500
Annual cost of operating gas engines..	9,286
Annual cost of operating steam engines	4,539
Probable cost of purchased current....	8,126

A saving of about $3587 annually by the use of steam engines was demonstrated to be possible in this plant.

EASILY MADE PRONY BRAKE

THIS brake is made cheap and is suitable for testing gas engines, etc. The drawing requires but little explanation. The band is made of malleable sprocket chain links of the detachable variety. One of the links to which the wooden blocks are fastened by means of sheet-iron clips and wood screws is shown at A. This form of link can be bought for a few cents.

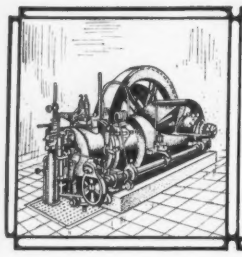


HOME-MADE PRONY BRAKE

It is evident that such a brake band can be easily adjusted to any size pulley or flywheel by taking out or putting in links as required.—Machinery.

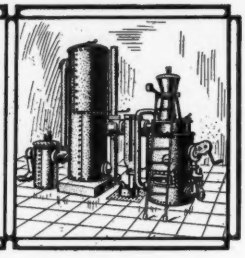
A ROUND FILE may be used as a reamer by inserting it in the hole to be reamed and turning to the right instead of to the left. By doing so the file will not bind and excellent work will result.—Penberthy Engineer and Fireman.

THERE IS MORE economy in keeping your eye on the steam gage than on the clock.



Gas Power Apparatus

Producers, Engines and Industrial Applications



MENASHA MUNICIPAL POWER PLANT

CRUDE OIL ENGINES: TRIPLEX PUMPS

SMALL municipalities frequently take the initiative in equipping their power plants with apparatus which has not passed the experimental stage and lacks the recommendation of some of the best engineers. Such a course is sometimes an expensive experiment, but the city of Menasha, Wis., which equipped its power plant with crude oil engines in 1906, has had economical results far beyond its expectations.

This plant is used for pumping water and generating electricity for lighting the streets of the city. In the final test of the engine the system of water mains were shut off from the line of pipe leading to the tower, and the water drawn from the tower until the gage registered 35.5 lb. The plant was then started to warm up the machinery, the record of the oil gage was taken, the clutch thrown in, and the pumping machinery started. Under these conditions, the plant was operated for 1 hr. and 22 min. when the tower overflowed; the gage registered 63.5 lb., and the plant was shut down.

The quantity of water pumped was 86,000 gal., at an average pressure of 49.5 lb., with the use of 4.4 gal. of oil. At the rate of 4 cents per gallon for oil, the price paid at the time, it will be seen that the cost for pumping 1000 gal. of water was 0.2 of a cent.

In this plant the equipment consists of 2 crude oil engines for furnishing the power, 2 air compressors which supply compressed air to the engines, 2 single-acting triplex pumps, an alternating-current generator, and an exciter.

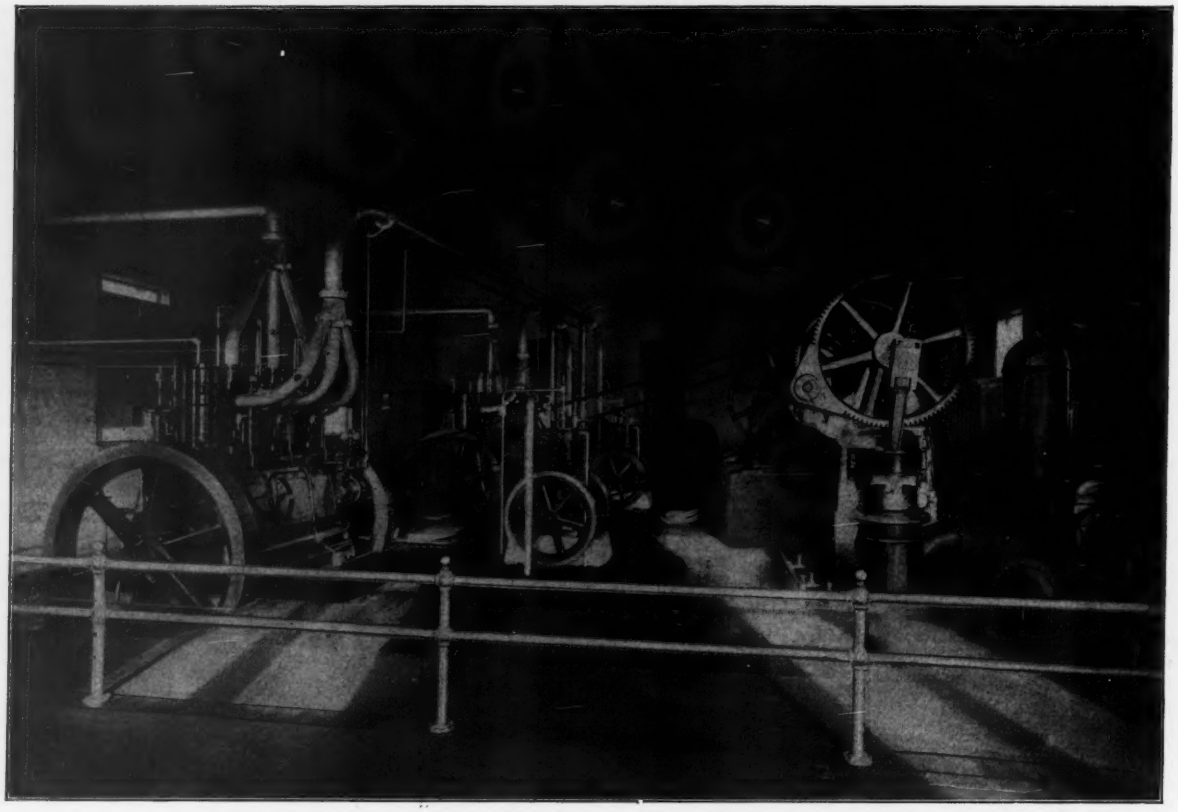


FIG. 1. GENERAL VIEW OF MENASHA POWER PLANT

Engines

ENGINES are the product of the American Diesel Engine Co., and are rated at 75 hp. each, with 3 10 by 15-in. cylinders, and run at 240 r.p.m. Lun-

kenheimer oil cups are used for lubricating and each of the engines has a muffler in its exhaust line. Belted to each engine is a Goulds triplex pump and an air compressor; to engine No. 2 there is also belted a generator.

This type of engine operates on a 4-stroke cycle. In the first or downward stroke the piston moves to the bottom end of the cylinder, and at the same time, either by suction or mechanically, the air admission valve opens, and allows the cylinder to fill with fresh air at atmospheric pressure. During the second, which is an upward stroke, the air is compressed to a pressure of 500 lb. per sq. in., at which pressure it has sufficient temperature to ignite any form of petroleum spontaneously. There are no valves open during this stroke and there is nothing in the cylinder but pure air.

When the piston has reached the end of the compression stroke and the crank is just crossing the dead center, a small needle valve, called the fuel valve, opens, and a mixture of fuel and compressed air is blown into the already hot air in the cylinder. The quantity of fuel is not all blown in at once, instead it continues over a period equal to 10 per cent of the downward stroke of the piston. This is possible by reason of the small quantity of petroleum necessary and the mixture with compressed air which increases the volume and thus gives a quantity whose injection can be controlled. The compressed air referred to is supplied by the independent compressor and cooled before induction to the fuel valve.

After the needle valve closes, the hot gases expand until the piston has traveled 90 per cent of its stroke when the exhaust valve opens to release the pressure before the commencement of the next upward or exhaust stroke. The pressure at the opening of the exhaust valve for normal load is generally 35 lb. per sq. in., and the temperature about 700 deg. F. The last stroke of the cycle takes place with the piston traveling upward, the exhaust valve open, and the hot gases rushing out through the port and valve.

When the piston reaches the top center, the exhaust valve closes, the admission valves begin to open, and the whole series of operations is repeated. Injection air which is supplied by the air compressors is regulated in pressure by the engineer according to the load. After the air is compressed, it is stored in bottles which are connected by a common pipe and supplied with Crosby gages. At halt load the pressure employed is 50 to 60 atmospheres. Above

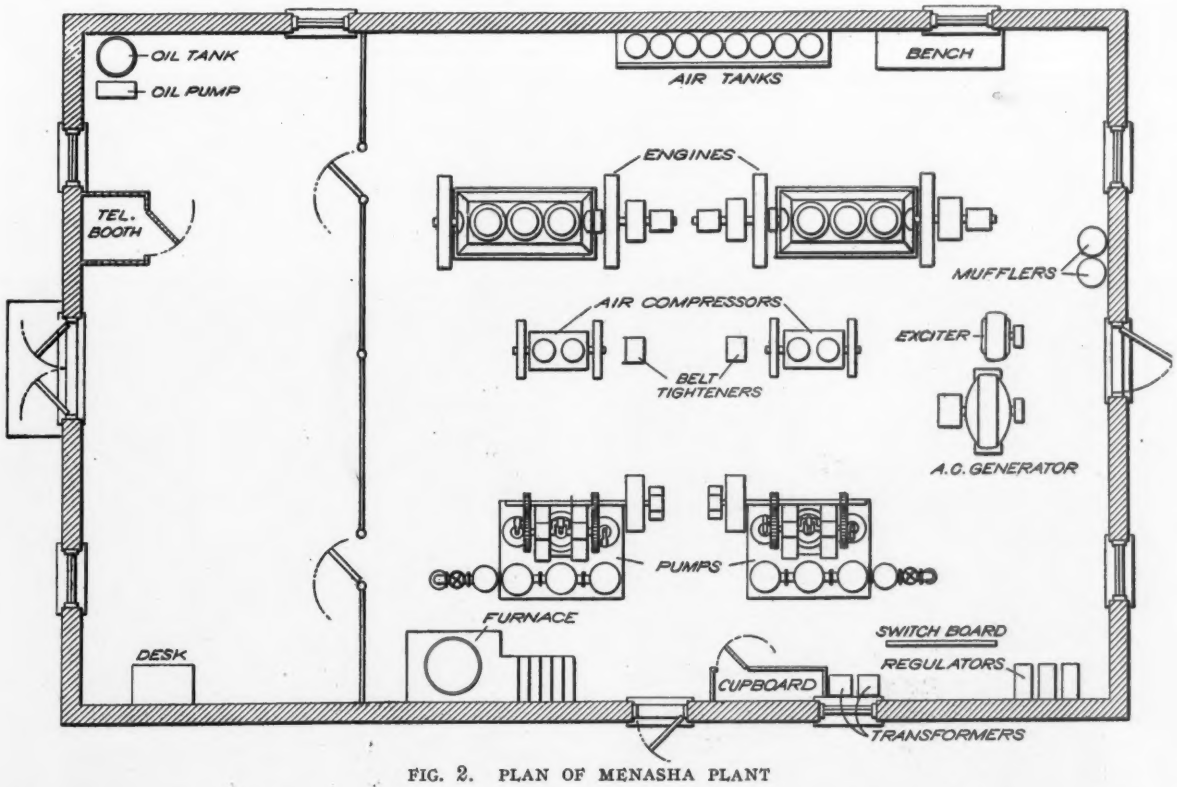


FIG. 2. PLAN OF MENASHA PLANT

that load 65 to 70 atmospheres, and where a peak load runs over the rating, 75 atmospheres is desirable and permissible.

Water used for cooling the cylinders is discharged into a funnel in sight of the engineer and is kept at a temperature not to exceed 130 deg. F. at any time. Several tests have proved that the efficiency is just as good at that temperature as at any other, while the danger of cracking the cylinder head arises when higher temperatures are used, because the temperature inside the head over the combustion port is always higher than at the overflow, the water heated at this point being cooled somewhat when it unites in the general outflow from the head.

The water used for cooling the fuel valve is cool to the touch, and after it goes through the exhaust chamber it is also discharged into a funnel in sight of the engineer, so that if at any time the combustion is dirty the engineer will see it and, noting which cylinder, will know where to look for the cause.

The air compressors which are driven by belts from the engines at 120 r.p.m., are of the 2-stage type made

by the American Diesel Engine Co. They are equipped with Crosby safety valves and Lunkenheimer lubricators; each has 2 flywheels. The cylinders are 8 and 2.5 by 8 in. and are water cooled, delivering air at from 900 to 1100 lb. per sq. in. pressure.

Pumps

PUMPS operated by these engines are, as stated above, driven by belts. They are made by the Goulds Mfg. Co., and are of the single-acting, triplex type, with 13 by 12 in. cylinders, and run at 40 r.p.m. At this speed each pump is rated to deliver 1.25 million gal. in 24 hr.

Each pump is equipped with a Kearns safety valve, which will relieve the pump of an undue pressure during times when it delivers water direct to the mains. On the discharge line from each pump is placed an air chamber, also a check valve made by the Michigan C. & I. Works, and, as a check upon the amount of water pumped, a revolution counter made by Schaeffer & Budenberg Mfg. Co. is placed upon each pump. The bearings are lubricated by means of ordinary oil cups.

On the gage board is placed a water gage made by Joseph P. Marsh & Co., which is a combination showing the pounds pressure per square inch, and the height of water in feet, which are normally 54 lb., and 125 ft. respectively.

In the city of Menasha are about 7000 inhabitants, the daily consumption of water being in the neighborhood of 300,000 gal. This water is drawn from the channel of the Fox River, upon the bank of which the power house is located, with a suction of 7 ft. upon the pumps. It is delivered from the pumps to the tower, which has a capacity of 179,000 gal., being 15 ft. in diameter, and 135 ft. high, making it in all 142 ft. above the level of the river. In the pipe line at the tower is placed an Engberg electric hydraulic valve made by the Engberg Electric & Mechanical Wks., which is operated by a battery at the power house and used to shut the water off from the stand pipe in case of a fire, when direct pressure is placed upon the mains.

Electrical Equipment

FOR generating the electricity to light the streets, an alternating-current generator is employed, which was made by the National Electric Co. It has a capacity of 60 kw., and delivers 3-phase current at 60 cycles and 2300 volts, the current capacity being 15 amperes per terminal, and the speed 900 r.p.m.

The exciter for this generator was made by the same company, and is run by a belt from the main generator. It is rated at 3 kw., giving direct current at 80 volts, and runs at a speed of 1750 r.p.m.

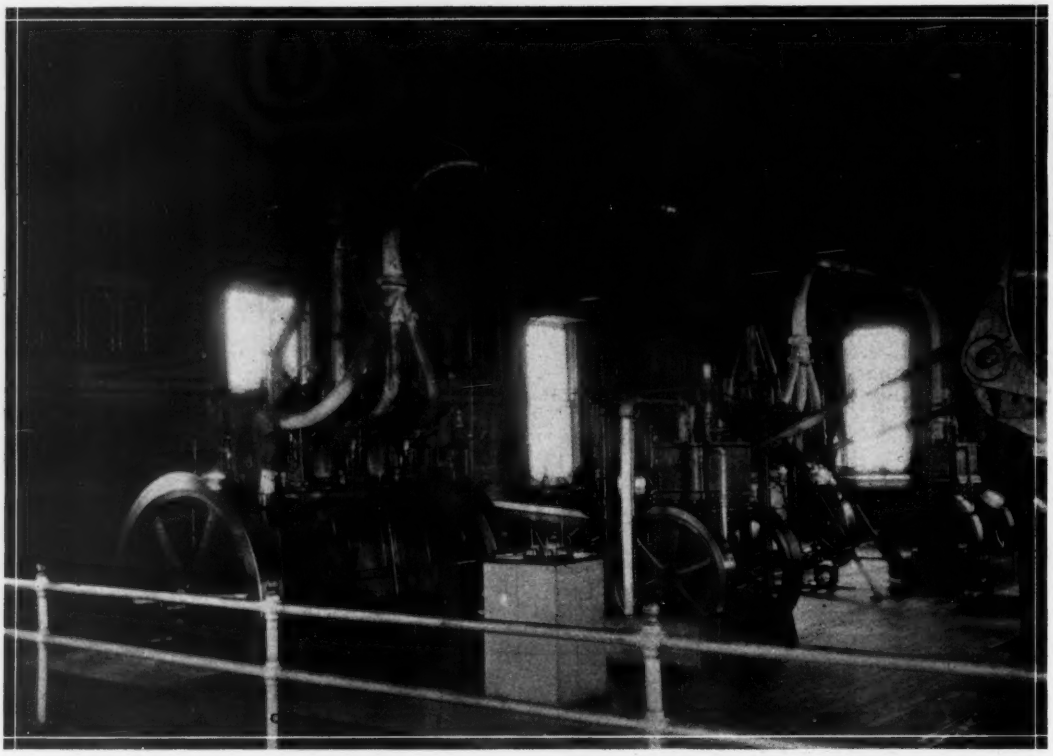


FIG. 3. CRUDE OIL ENGINES AND AIR COMPRESSORS

The switchboard consists of 2 panels, each 36 by 14 in., and is equipped with ammeters, voltmeters, a 3-phase oil switch and circuit breaker, all made by the Stanley Electric Mfg. Co., and also an enclosed type rheostat for field control made by the Cutler-Hammer Mfg. Co. Other equipment such as voltmeter plugs, small switches, fuses, etc., are supplied in order to give the operator full control and eliminate danger to the generator.

For maintaining a constant current upon the 3 arc lamp circuits, which carry 6.6 amperes at 60 cycles to 80 arc lamps used in illuminating the streets, 3 current regulators are employed. In the station are also 2 transformers, each being wound with 5 leads by means of which the voltage on 2 of the lines, which have somewhat variable loads, may be changed to suit the existing conditions. These type B. O. trans-

formers are rated at 6 kw., with a ratio of 3150 to 2300 volts. Protection to the station against lightning is afforded by 3 lightning arresters. This apparatus is all the product of the Stanley Electric Mfg. Co.

Sufficient heat during the winter time to warm the building is not radiated from the engines so a Hesper vertical steam boiler is employed. This is equipped with a Novelty Iron Works Gage and a damper regulator made by Powers Regulator Co., which keeps a uniform temperature in the power house.

The storage tank for the crude oil is placed in a separate concrete building and has a capacity of 10,000 gal. The average consumption of the plant for

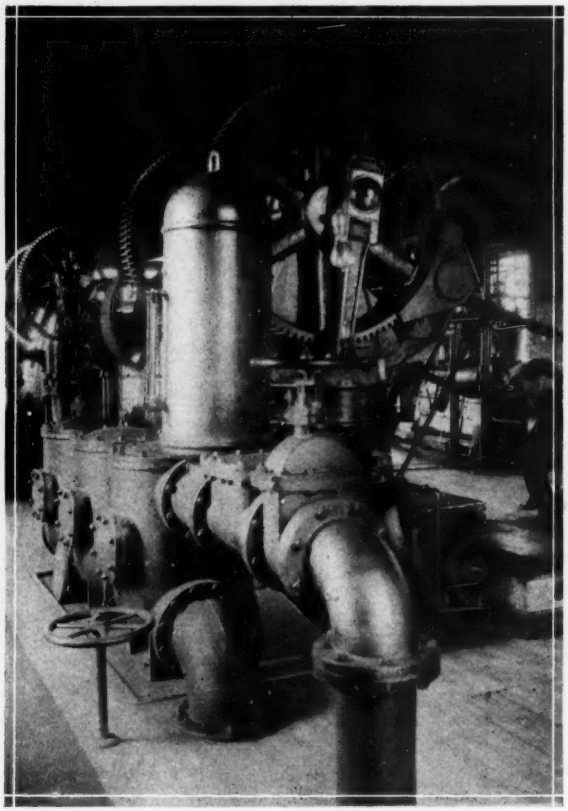


FIG. 4. TRIPLEX PUMPS IN MENASHA PLANT

a year is about 26,000 gal. From the storage tank, the oil is pumped to a supply tank in the engine room which has a capacity of about 10 gal., by means of a Rumsey & Co. oil pump. From this supply tank the oil is fed by gravity to the engines.

The operating force of this plant consists of the chief engineer, Simon Reimer, and his assistant who do the entire work of the plant and keep it running night and day. The results obtained are certainly gratifying and the city contemplates the addition of another unit when commercial lighting will be carried on.

HE WHO CRITICISES is your friend; treat him as such. He who flatters is to be regarded with caution. What is his motive? But flattery and honest praise are not the same.

PRODUCER GAS PLANTS FOR SMALL CENTRAL STATIONS*

BY W. B. HEAD

SINCE fuel is the chief item in the cost of operation of a power plant, any installation that will give satisfactory service and materially reduce the fuel consumption, means much to the man who has money invested. The producer plant will do this, and it is my opinion that it is the only hope for many small central stations.

Operating on Texas lignite, several builders of producer plants are guaranteeing a fuel consumption of 2 to 3 lb. of lignite per brake horsepower per hour on a 70 per cent load factor. When we remember that Texas lignite can be had at a cost of about one-half that of Oklahoma coal, the great saving can be understood.

The action of the gas producer has been frequently explained in the pages of Practical Engineer so that Mr. Head's description is omitted.

The question uppermost in the minds of prospective purchasers is the reliability of the outfit. It matters not how economical the outfit may be if it cannot be depended on to meet the exact requirements of the central station. After a year's experience with a 100-hp. unit, I feel safe in saying that a first-class producer plant is as reliable in every respect as a steam plant. A somewhat better class of labor is needed to operate a producer than a steam plant, but skill on the part of the engineer is not so necessary as carefulness, particularly when handling the engine.

Lubrication costs about one-third more than for the steam engine. The matter of durability of the producer plant rests almost entirely with the engine, as there is almost nothing about the rest of the plant to depreciate. I have no accurate information, but I think that the upkeep of a gas engine compares favorably with that of a steam engine but is somewhat larger. The installation cost is about 40 per cent more than for a steam plant.

There are a few points that should be considered by the prospective purchaser: First, the amount of water necessary for the tar extractor and scrubber, also the amount needed for cooling the engine cylinders. In Texas in many places it would be almost impossible to secure sufficient water for these purposes without providing cooling systems and thus using the water over again. In locating the producer room, care should be taken to have the floor high enough so that water from the tar extractor will have considerable fall and get out of the building easily. In cold weather, the tar becomes thick and is hard to pass through a sewer without considerable fall. Some sort of skimming device should be provided to separate the tar from the water so as to save the tar. For plants of 100 hp. and larger a coal elevator for charging the producer should always be provided.

A SOLDER THAT will fuse at a low temperature and used in uniting soft metals is made by adding 3 drops of mercury to each ounce of common solder.—Penberthy Engineer and Fireman.

*Read before the Southwestern Electrical & Gas Association.

KEROSENE VS. GASOLINE

AS FUEL FOR THE INTERNAL COMBUSTION ENGINE

By C. C. Austin

DEVELOPMENT of the kerosene engine in the United States has received little attention up to the present time, manufacturers and users of internal combustion engines preferring to use gasoline at a higher cost because it was considered more reliable. But today engine manufacturers, particularly those making farm tractors, are giving the kerosene engine attention, and many of them are being sold.

Recently a series of tests was run under the writer's direction by Messrs. Strait and Thomas, seniors

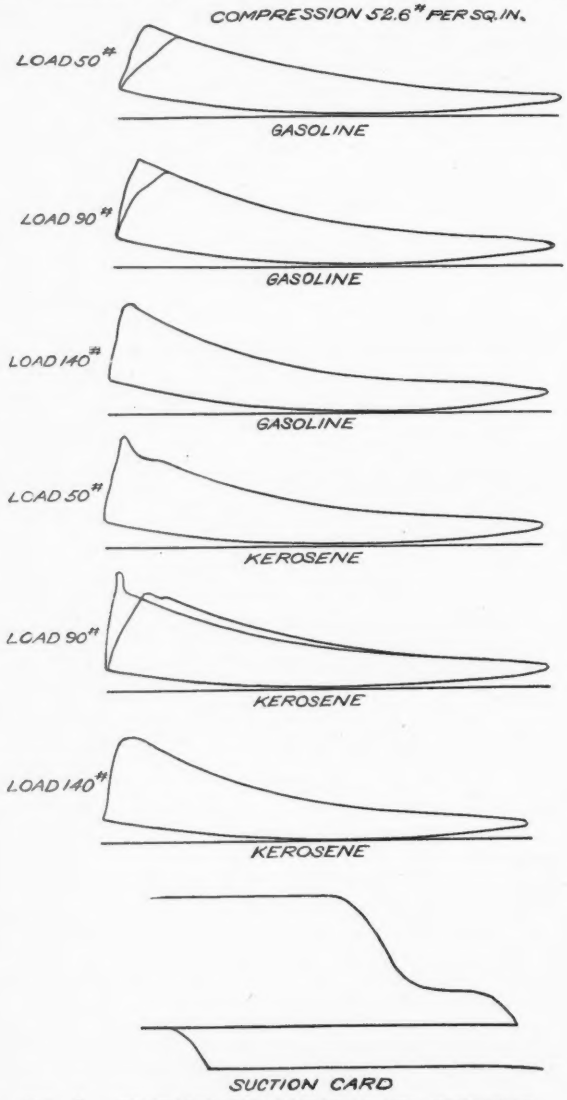


FIG. 2. DIAGRAMS FOR GASOLINE AND KEROSENE AT COMPRESSION 52.6 LB.

in the mechanical engineering department of Purdue University, to determine the relative merits of each fuel under the same operating conditions with varying compression and under the best conditions obtainable with each compression. The point of ignition had to be changed with each compression, being delayed for the higher pressures.

The tests were made on a 20-hp., single-cylinder, horizontal 4-cycle Fairbanks-Morse engine, equipped with an external vaporizer for burning kerosene. The head end of the engine and the vaporizer in section are shown in Fig. 1. When using gasoline the valve V is opened so that the exhaust gases may pass directly through the top of the vaporizer to the atmosphere. The carbureters are all of the constant level type, being supplied by the pump GP at the right of

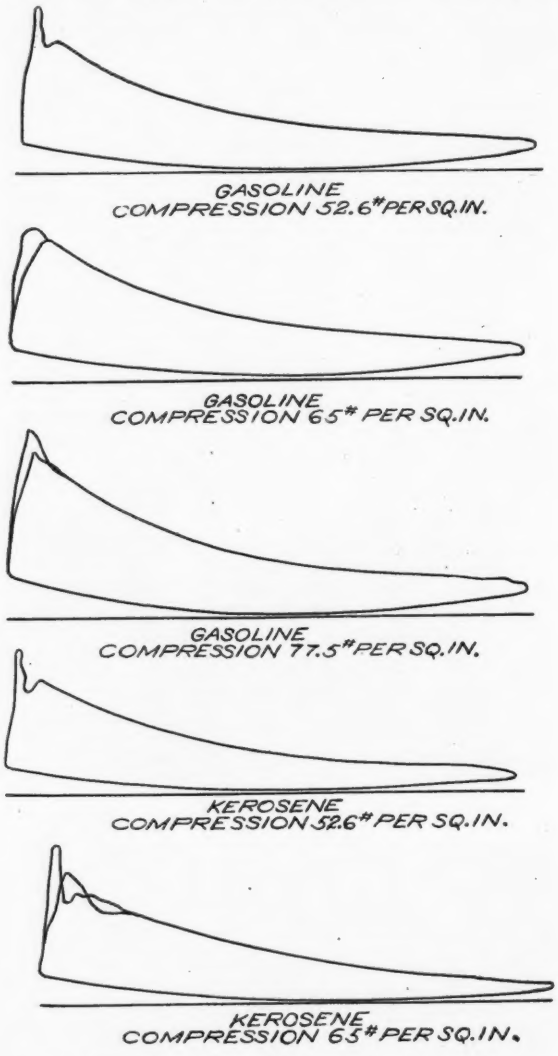


FIG. 3. "BEST CONDITION" DIAGRAMS TAKEN AT 140 LB. LOAD

the engine. The gasoline carbureter is at C. Operation of the engine on gasoline requires no further explanation.

When kerosene is used valve V is turned to the position shown in Fig. 1 and the exhaust gases are forced down around the baffle plate before they reach

the atmosphere. This process heats the inner corrugated head. Kerosene is pumped into the kerosene carbureter or oil reservoir at R, which communicates with the space 5. This space in turn communicates with the air through a pipe, which serves as an air

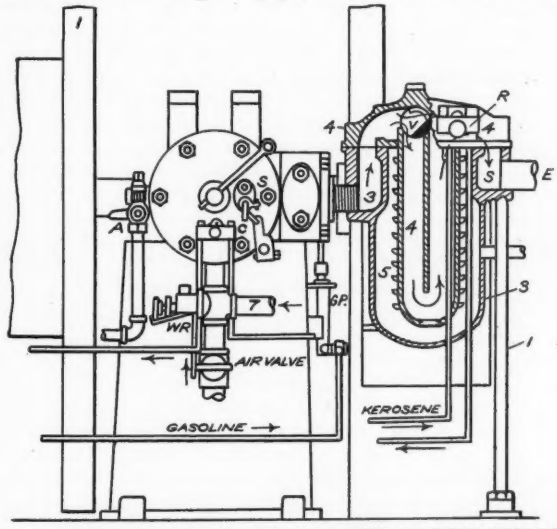


FIG. 1. SECTION OF KEROSENE VAPORIZER ON TEST ENGINE; A COMPRESSED AIR INTAKE; C, GASOLINE CARBURETER; S, SPARK-PLUG; W R, WATER RESERVOIR; G P, GASOLINE PUMP; 1, STANDARD OF VAPORIZER; 3, BODY; 4, UPPER HEAD; V, BYPASS VALVE; R, OIL RESERVOIR; E, EXHAUST PIPE

intake when using kerosene. This vaporizer is connected directly to the engine intake through 7 which is shown broken in the drawing. The operation then, when using kerosene, is as follows: The suction stroke draws kerosene from the kerosene carbureter into the heated space 5, where it is immediately vaporized. The air from intake pipe is mingled with this kerosene vapor in the correct proportions to give a combustible mixture which is burned in the engine in the ordinary manner. The engine is operated for a few minutes on gasoline to heat the vaporizer before throwing it over to kerosene.

the water carbureter admits a small amount of water with the gasoline or kerosene vapor and prevents the heavy knock; the fuel consumption is not affected.

Kerosene has a slightly higher calorific value than gasoline. It will not stand as much compression and

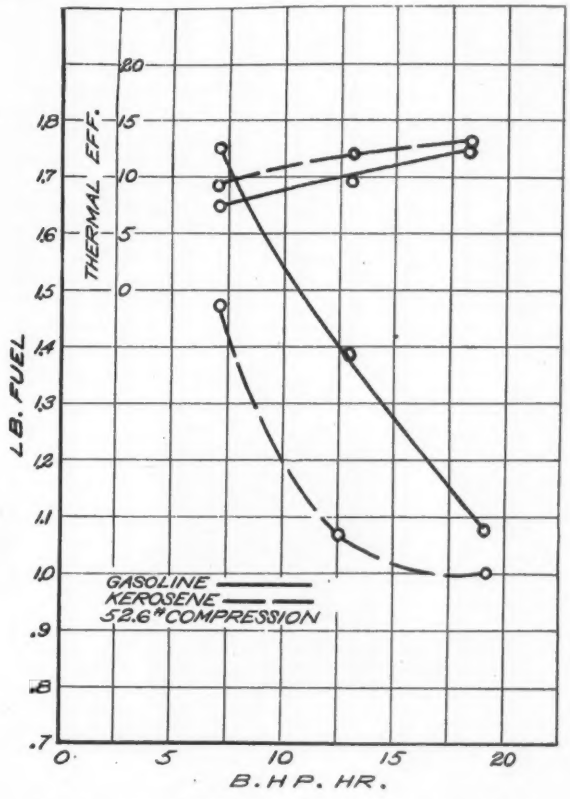


FIG. 4. CURVES SHOWING COMPARISON AT 52.6-LB. COMPRESSION

no data could be secured with kerosene on the highest compression. The engine required so much water in the fuel to prevent the excessive pounding that it would not carry the full load.

TABLE I. SUMMARY OF DATA AND RESULTS

	COMPRESSION 65#								COMPRESSION 52.6#							
	GASOLINE SPARK 12° EARLY			KEROSENE SPARK 12° EARLY			BEST CONDITION GASOLINE 16°	KEROSENE 13°	GASOLINE SPARK 16° EARLY			KEROSENE SPARK 16° EARLY			BEST CONDITION GASOLINE 23°	KEROSENE 15°
DURATION OF TEST, MIN.	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
BRAKE LOAD	50	90	140	50	90	140	140	140	50	90	140	50	90	140	140	140
R.P.M. AVERAGE	225.3	223.8	211.1	227.1	225	214.8	222	218.8	225.8	224	217.1	228	223.2	220.1	22.2	220
E.P.M. "	63.5	78.8	108.8	62.3	92.9	101.1	92.2	102.2	53.9	83.8	108.1	68.6	96.7	105.4	93.7	102.9
INIT. TEMP. COOL. WATER	59	57.1	54.5	58	61.3	58	52	52	55.4	52	52	56	66.2	56	56	56
FINAL " " "	182.1	177.2	178.5	177.5	178.3	177.7	179.5	182.5	179.5	182.8	185.1	185	180.2	181.1	182.8	178.2
WEIGHT COOL. WATER HR.	430	562	616	348	484	666	583	606	413.8	474	630	388	646	644	692	642
LB. FUEL PER HR.	14.15	15.8	17.9	11.24	11.72	15.0	16.18	19.8	12.38	17.48	20.60	10.2	13.45	19.1	17.6	14.45
M.E.P	74.9	76.3	78.4	67.0	74.5	83.1	96.4	79.7	76.1	7.82	81.0	77.1	74.8	83.2	9.25	7.35
I.H.P.	12.89	16.29	23.0	11.26	18.7	22.7	24.1	22.0	12.2	17.7	23.6	14.35	19.6	23.7	2.36	2.05
B.H.P	7.03	12.53	19.02	7.09	12.65	16.8	19.4	19.05	7.07	12.62	19.05	7.12	12.52	19.25	19.5	19.3
F.H.P.	5.86	3.64	3.98	4.17	6.05	5.9	4.7	2.95	5.13	5.08	4.55	7.18	7.08	4.45	4.1	1.3
MECH. EFFICIENCY	54.5	77.1	82.1	63.0	67.7	84.7	80.6	86.7	58.0	71.8	82.8	50.2	63.75	81.2	82.5	94
LB. FUEL B.H.P.H.	2.19	1.26	.94	1.58	1.08	.805	.833	.725	1.75	1.385	1.08	1.41	1.07	.99	.90	.75
B.T.U. SUPPLIED HR.	278,000	310,000	351,900	223,900	234,000	322,300	319,000	275,000	243,000	342,250	404,000	199,050	268,000	381,000	340,000	283,000
B.T.U. EQU. TO B.H.P.H.	17,900	32,000	48,300	18,250	32,170	47,800	49,300	48,500	17,800	32,100	48,500	18,100	31,800	48,900	49,600	49,200
B.T.U. TO COOL WATER HR.	52,800	67,500	76,350	41,500	56,700	72,800	74,500	79,200	54,500	62,100	85,250	50,160	73,600	80,700	87,850	78,350
B.T.U. EQU. TO F.H.P.H.	14,925	9,275	10,150	10,625	15,425	9,950	11,980	7,530	13,050	12,920	11,575	18,300	18,050	11,330	15,300	3,317
HEAT BALANCE %																
THERMAL EFF.	6.45	10.03	13.75	8.07	13.64	14.8	15.5	17.6	7.3	9.4	12.0	9.1	11.85	12.8	14.3	17.05
FRICTION WORK	5.37	2.98	2.35	4.75	6.5	3.09	3.74	2.73	5.37	3.79	2.8	9.17	6.72	2.97	3.01	1.14
COOLING WATER	19.08	14.0	17.72	17.1	24.2	22.6	23.3	28.7	22.4	18.0	21.1	25.1	2 7.5	21.2	25.4	2 7.3
EXHAUST & RADIATION	69.1	72.2	68.72	70.08	55.5	59.46	57.49	51.07	64.63	68.81	64.1	56.6	53.9	53.9	57.2	54.5

A special feature of this engine is a water carbureter, WR. This engine pounds badly when running under heavy load due to the high initial pressure, and

The chief difficulty when using kerosene was found to be that of maintaining the proper mixture of kerosene vapor and air and the entire operation of the en-

gine on kerosene was more erratic than on gasoline. Backfiring and misfiring occurred occasionally when using kerosene, but neither occurred when gasoline was

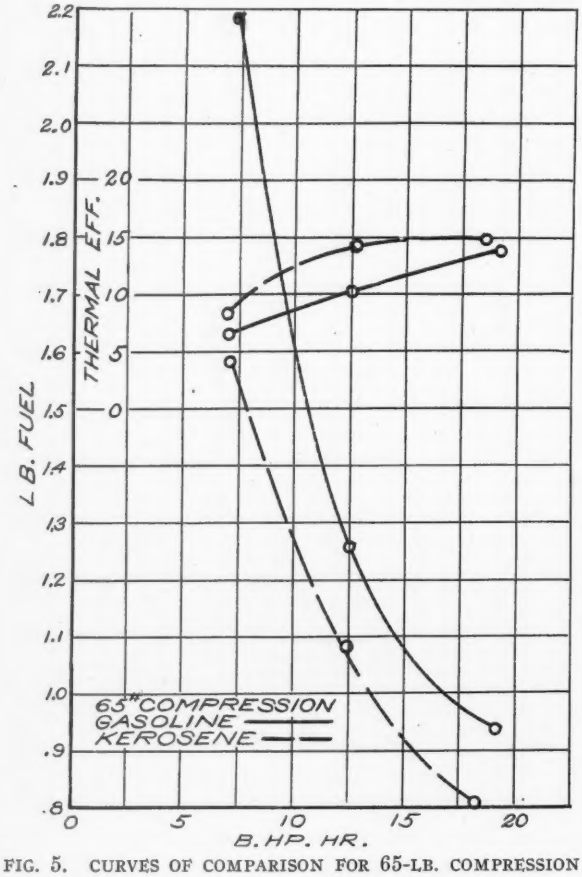


FIG. 5. CURVES OF COMPARISON FOR 65-LB. COMPRESSION

used. The uneven cards taken when using kerosene indicate a more erratic operation of the engine than do the gasoline cards.

Fuel consumption and thermal efficiency curves show that kerosene is far the more economical and

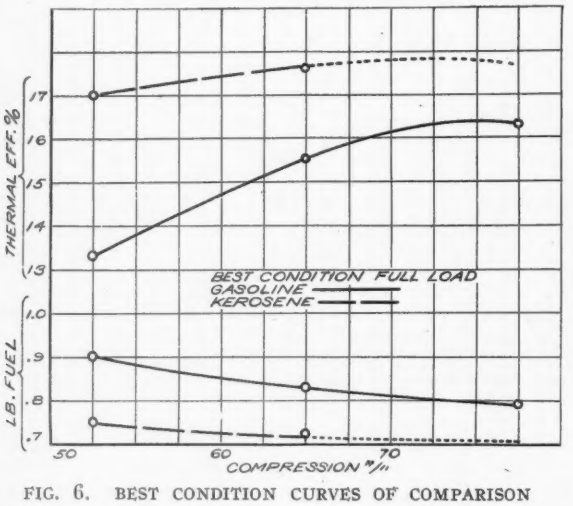


FIG. 6. BEST CONDITION CURVES OF COMPARISON

gives a substantial fuel saving so far as quantity alone is concerned. Also kerosene is not so expensive as gasoline, and both considerations are heavily in favor of the kerosene-burning engine. The tests show plainly that the reliable kerosene engine is to be preferred to the gasoline engine so far as operating expense is concerned.

In the gasoline trials at 77.5 lb. compression, the speed ran higher than with the lower compressions, mean effective pressure ran at 87 and 92 lb., indicated and brake horsepower were larger and the fuel per brake horsepower went down to 1.54, 1.04 and 0.88 lb. for 50, 90 and 140 lb. brake load respectively. Mechanical efficiency was lower, but thermal efficiency was higher than for the lower compressions, although heat to the cooling water was increased and that lost in exhaust and radiation was diminished.

PEAT FUEL FOR GAS PRODUCERS

IN OUR enthusiasm over future possibilities, we are often inclined to overlook the stern realities that arise to confront us whenever we attempt to put our theories into practice. During the past 2 or 3 years much has been said of the use of peat as fuel in gas producers, and we have congratulated ourselves again and again that, at last, the proper way to make peat fuel a commercial success had been reached—build gas-producers and run electric plants with them, and thus convert the stored up energy in the peat to power.

It is a perfectly simple and easy thing to do, without doubt, and entirely practicable; in this way also the very highest value possible in heat units can be obtained from peat; but how many of us have ever made a careful esimate of the amount of peat fuel that is required to develop 100 hp. in the form of electric energy ready for delivery, for a year?

If it is assumed that the producer gas is generated in well-designed gas producers and used in suitable gas engine, and that the peat is of good quality, 3 lb, of peat will probably furnish a single unit of power, a horsepower hour, at the switchboard; but let us assume that 3.5 lb. are needed, in order to have a sufficient amount, and it is apparent at once that the quantity of fuel used each hour for 100 hp. would be 350 lb., or 3,500 lb. per 10-hour day.

The plant is operated for 300 days, we will assume, and during that time 525 tons of fuel will be needed to which must be added that needed to keep the fires going during the remaining time, which may be estimated to amount to 100 tons more, making a total of 625 tons for the plant for the year. This is smaller than the requirement of coal for boiler purposes for the same amount of power, without doubt, so that the showing is excellent for peat, so far.

It is the procuring of the necessary 600 or 700 tons of peat as needed, and in suitable condition to use, that is the retarding factor. This again is a small matter, for a plant with a productive capacity of 50 tons of dry fuel a day, would easily turn out that amount in 12 or 14 days of favorable weather, we say, but, unfortunately for our enthusiasm, when we are asked by the owners of manufacturing plants where they can see a peat fuel plant in operation, that is making 50 tons of peat fuel a day, we can only answer, "In Europe."

Herein lies the weakness of the situation for us, and here it is likely to remain as long as the total peat fuel production for the entire United States remains as small as it has been up to the present. It is essential, to show a way by which a good quantity of reliable, dry fuel can be made, day after day, for an entire season, before men who want power for plants which

must be run throughout the entire year, at the highest rate of efficiency, will consider peat fuel as a possibility for gas production.

It is not a matter of experiment simply, but one of actual doing, on a commercial basis, with plants that are well equipped and financially supported until the men running them have gained experience and know what they have to do and how they are going to do it. They must know how to make a 10-ton plant produce 10 tons of finished product every day during the season, at the least possible cost price. It is not a question of making 10 tons once in a while to show off the plant to visitors, but of keeping the operations going at the highest speed every day during the season, and making each day a test of the utmost capacity of the plant.

Until this is done by at least one plant, for which no excuses need be offered and no explanations need to be made, that it lacks this or that, it is not to be expected, or hoped, that we shall hear much of the erection of electric or other power plants equipped with gas producers for utilizing peat fuel.

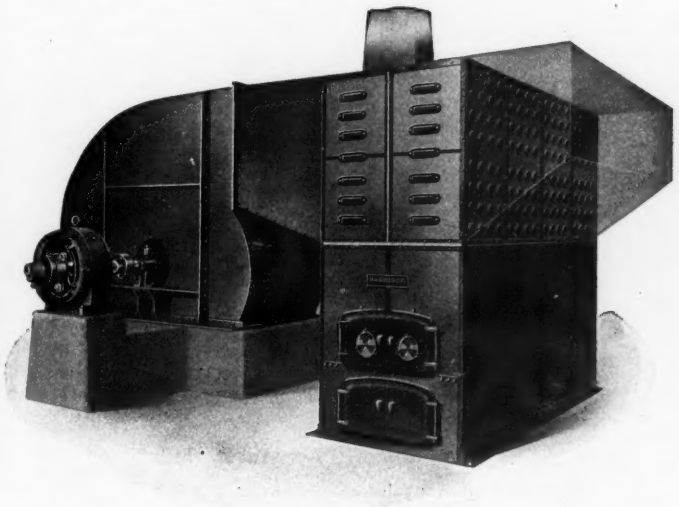


FIG. 1 HARRISON AERTUBE HEATER WITH DIRECT DRIVEN ELECTRIC FAN

The situation at present seems to be hopeful, that, within a season or 2, perhaps this coming one, more than one small, fully equipped peat fuel plant will be operated as outlined above. May that time soon come!—Journal American Peat Society.

AERTUBE HEATER FOR GAS

VARIOUS savings that would be possible by the use of a direct fuel-to-air heater have led to the invention of several direct heating systems, but their heating area has not been great enough to transmit the large amount of heat required in a fan system; and not being adapted to sectional installation, these heaters have been of limited individual capacity.

The Harrison Aertube system consists of a furnace under a bank of horizontal tubes through which the air to be heated is driven by a fan, and the distribution ducts. For use in a gas engine driven plant it solves the heating problem to begin with, and offers small opportunity for repairs. This is the first great reason for its economy.

Hot gas from the fire strikes directly on the heating tubes, and is distributed among these by baffle plates. The transfer of the heat of the fire to the air passing through the tubes is direct and immediate, and begins as soon as the fire is started. An efficiency of 80 per cent or more of the heating power of the fuel is guaranteed in the Harrison heater, and has repeatedly been exceeded on tests.

In the Harrison Aertube the air moves through the tubes in a straight line from the fan to the distributing ducts, and parallel with the heating surfaces. In addition, the Aertube is made on the sectional plan, and so may be adjusted to the heating load in any special case.

While the Harrison system is applicable in any type of building, it is especially satisfactory where the heating system must also provide mechanical ventilation, as in schools, churches, theaters and other buildings of more or less public character. It is particularly adapted to buildings which have electric or gas power, and also for factories with hydro-electric power. It is made in tubular units or sections of 32 tubes each, the tubes being 4 in. in diameter, 4 ft. long, and supported at the ends

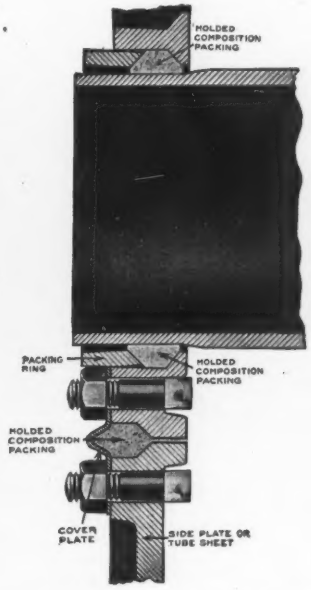


FIG. 2. JOINT IN TUBE SHEET OF HARRISON HEATER

in cast-iron tube plates. The patent joint between each tube end and the tube sheet consists of a ring of molded composition packing held in place by a cast-iron expansion ring. It is flexible enough to allow for expansion and contraction, yet absolutely prevents any gas from the furnace getting into the air. The different parts of the casing are jointed on the same plan, the composition packing being held in place by cover plates held by through bolts.

Fuel adaptability is another particularly strong feature of the Harrison heater. While coal is the usual fuel, the Aertube works remarkably well on the exhaust from gas engines, from forges, ovens and the like; and such otherwise waste heat can, if necessary, be used in combination with the burning of fuel on the grate to make up any deficiency. Crude oil gives excellent results. Producer gas is a highly satisfactory fuel when a group of buildings is to be heated, since the gas can be piped from a central producer to Aertube heaters in the various buildings.

IN SALT LAKE CITY a new $25,000 plant, transformers and generating units is to be erected at State Road and Highway 66 by the Utah Lt. & Ry. Co.

REMINISCENCES OF AN ERECTING ENGINEER VI

ASSEMBLING THE VALVE GEAR

By M. E. P.

WE ARE ready to assemble the valve gear and before detailing the method of doing it I want to say a few words about cleaning the parts. All of the bright work is painted with white lead and tallow before it is shipped and this paint has to be removed before the parts are assembled. It is best to have this done about as the pieces are wanted rather than to have it done all at once. The paint will be hard to remove unless something is used to soften it and 2 things are available, gasoline and kerosene, of which the latter is the better as it does not dry so readily and leaves a greasiness on the metal that gasoline does not. Don't use waste for cleaning, use rags as they leave less lint and it is easy to wash them out in the kerosene and use them over and over.

When a piece is clean, put it in place and bolt it and, if polished parts are exposed, smear them over with cylinder oil so that they will not rust. I want

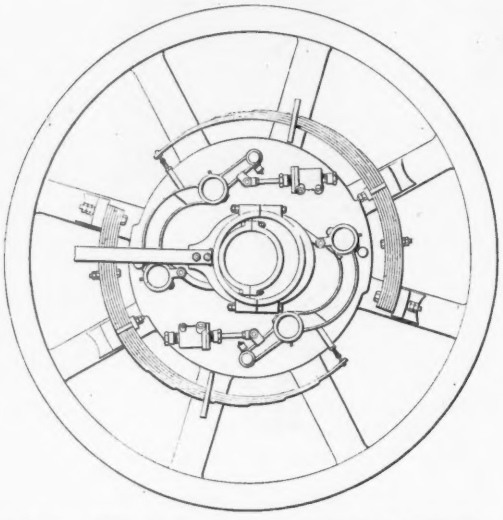


FIG. 1. GOVERNOR AT OUTER POSITION SHOWING ECCENTRIC CONSTRUCTION

to repeat my caution about rubbing the palm of the hand over surfaces that are to be put together so as to remove all lint and dust just before the parts are brought into contact. It will save you a lot of trouble if you will only heed this.

McIntosh & Seymour Gear

OF COURSE I cannot give specific directions about the assembling of valve gears unless we take some particular make of engine and assemble that. All engines can be erected in the same general way but each make will have something peculiar to itself that an erecting engineer will have to learn for himself. I will take the case of a McIntosh & Seymour engine as that would likely bother the average engineer as much as any valve gear built, although it is simple when one comes to study it a little and gets the theory of it into his head.

On each cylinder are 4 valve gear brackets that are bolted on and we can trust this work to an intelligent man while we are handling more difficult parts of the work. We will start on the eccentrics and get the main eccentric blocks on the shaft. They are made in halves and bolted together. Look for the marks and see that they are put in the right place. The straps are put on and the auxiliary eccentric shell put on the shaft. The auxiliary shell is made a running fit on the shaft and it should be tried to see that it does not bind but will revolve freely clear around the shaft.

Very little end play is allowed it and the main eccentric on the high pressure side will be set so that it nearly touches the auxiliary when the latter sets solid against the hub of the flywheel. After the straps are on the eccentrics, the brass heads are screwed into the main eccentric straps until the tram sent with the engine fits into the 2 center punch marks on the head and strap. The main rocker arms are attached to the back columns and are already in place as we put them up before the receiver. The eccentrics are attached to these arms by means of the brass heads and steel pins and we can put up the auxiliary cross-over shafts. These are attached to the receiver and the brackets were bolted on before we put the receiver in its place.

After the cross-over shaft is up the remainder of the platform had best be assembled as there is nothing else that we shall be obliged to handle with the crane that the platform will interfere with and some of the valve gear passes through slots in the platform. It also makes it easier to get around over the engine. There are no special difficulties in assembling the platform and stairs so I shall pass over this point with no particular remarks.

Adjusting Length of Rods

WHEN the cylinder brackets are all in place, the valves and stems and all of the rigging on the cylinders are ready for assembling, and this work calls for the direct supervision of the erecting man. Be careful to see that the valves are put in the proper chests and that the right stems and parts are attached to them. Every piece is marked plainly and must be carefully cleaned and oiled before being put in place.

If the valve stems have metallic packing, as is quite usual, that has to go on the stems before they are screwed into the little crossheads. You will notice that the crossheads and stems have prick punch marks surrounded by a circle and these same marks will be found on the face of the cylinders just over the valve stem stuffing boxes. These marks are for use in the setting of the valves. There is a set of trams sent with the engine and the one with its points bent at right angles to the body of the tram will be wanted for use when the valve stems are screwed into the crossheads. One point of the tram is set into the prick punch mark in the crosshead and the stems are screwed in until the other point of the tram will just fit in the mark on the stem. This system of tram marks is used all over the valve gear, clear from the eccentric straps to the valve stems. It is a very simple method of valve setting and one that makes it as easy as possible to return the valves to their "shop setting" if they have been moved for any reason.

The McIntosh & Seymour valve gear is a system of bell cranks and connecting rods, the rods nearly always terminating in brass heads into which the rods screw and in all cases the rods and heads are marked for the tram as I have already described. In the vertical engines there are long, flat reach rods used in some parts of the gear, but these are also marked the same as the others. When the valve brackets are shipped, some of them have short shafts carrying bell cranks on them all assembled and these shafts must be taken out and the bearings cleaned before they are finally connected. It is never safe to allow an assembled part to go without taking it down and cleaning it after it has been shipped for a long distance and has been exposed to dust and dirt for some time. Even though the part has been boxed and care taken to keep it from the dust it will be dirty and full of grit and this must be removed before it is put into its place.

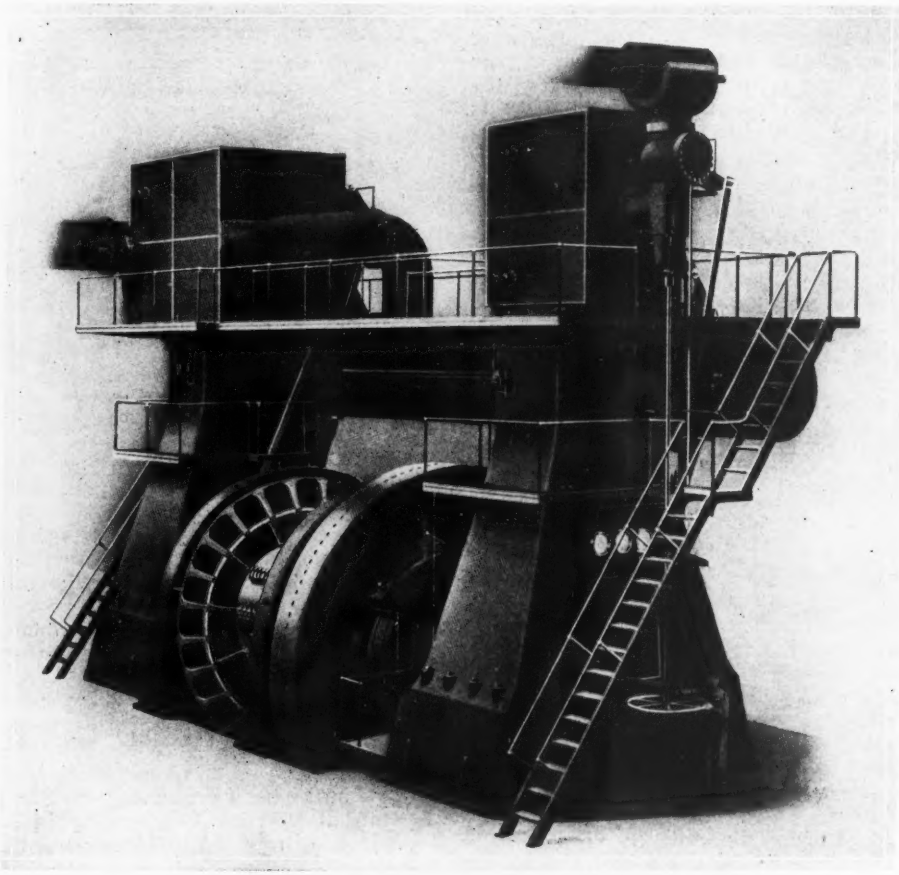


FIG. 2. M'INTOSH & SEYMOUR ENGINE ASSEMBLED

It is not necessary to describe the putting together of all the details of a valve gear. The erecting man will be familiar with the particular gear he has in charge and each of them has some peculiarities that will necessitate a little different order of assembling from a gear of a different make. This has to be learned by experience and trial rather than by any definite instructions.

Assembling the Governor

AFTER the small parts of the valve gear are assembled the governor is next in order. Still referring to the McIntosh & Seymour engine, the governor is rather a difficult problem to one who does not know much about it. The first thing is to get the arms in place. The easiest way is to sling a chain block from the upper platforms so that the block will hang directly over the center of the shaft and as close to the wheel as possible. Turn the wheel so that the hole through the governor arm will come about in line with its hole in the wheel arm and put in the pin and screw up the nut on the pin, being sure that it is tight and that the pin is clear to the shoulder. Try the arm to see that it works freely at all points in its range and then turn the wheel to bring the other hole into position for the second arm.

Two small bronze links are attached to the auxiliary eccentric block and the free ends of these are to be connected to the governor arms, each one to the arm bearing the same number as is found on the end of the links, see Fig. 1. After these are connected, try working the governor arms in and out to see that everything is free and does not bind at any point in the entire stroke of the arms. Put the stop pins, that the governor arms strike against when in the outermost position, in place and then you are ready for the springs.

Each spring is numbered and must go in its proper place and it may be that there will be certain small blocks to go under the heel of one or both of the springs. The drawings sent with the engine will tell you that. Sling the spring so that it will hang about perpendicular and put the long bolt that goes through the heel of the spring into its place, then the block on

it, if there be one, and then turn the wheel until the lug on the arm that the spring is attached to is about in line. There are 2 lugs for each spring, one which has a hole through it to take the heel of the spring, and one which has 2 holes tapped in it for studs which have a flat strap across them to hold the spring at a point about a fourth of its length from the heel.

It may be that there will be a cast-iron block made just to fit between these studs and under the spring when it is in place, the drawing will show, if so, put it in place before the heel bolt is entered. Drive the heel bolt through the lug and pull up the nut as snug as possible. This is quite hard to do as the spring is composed of several leaves and the bolt has to take the spring out of them before it seats solid. Put the clamp on over the 2 studs and screw down the nuts and lock them firmly with the lock-nuts. There is a guide yoke that is to be driven through a hole in the second arm from the tip of the spring and that is now

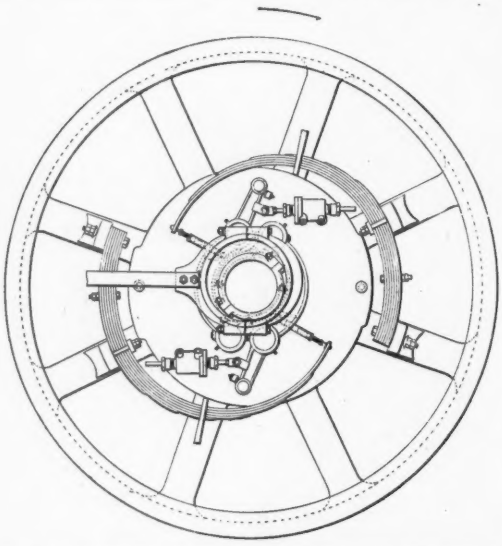


FIG. 3. GOVERNOR WITH SPRINGS IN INNER POSITION

to be put in place. It should not drive too hard, as it will have to be turned about a quarter turn after it is nearly in.

Repeat these operations for the second spring and then put in the governor pins. These pins are made in 4 parts, a piece of extra heavy steel pipe and 2 heads. One of the heads is made to fit into the tube and has a ball-shaped recess in its other end. The other head is a nut made to fit the tube and has a screw terminating in a ball. There are several sets of tubes sent with the engine and it is best to start with the shortest set in place.

Hitch the tackle to the end of one of the springs and pull it out as far as necessary so that the assembled pin will go in place. The cupped end fits on a ball in the governor arm and the ball end fits into a cup which fits in a hole in the small end of the spring. Turn the wheel and put in the second pin the same way, being sure that the pin tubes are the same length Put the dashpots up after filling them with cylinder oil and packing the stems, then connect them to the governor arms, and the governor is all assembled. It is well to hook the chain block on to the end of one of the governor arms and pull it out as far as you can and then slack it back as quickly as possible, doing this several times to make sure that there is no binding anywhere. It may save you some trouble when you put the engine under steam.

The next step is to finish with the valve gear and about all that is to be done is to put on the reach rods from the auxiliary eccentrics and whatever of the larger rods have been left. These rods have not been put up before because it would make too heavy a load on the governor while we were testing it, but after we have them up it is well to try the governor once more to be sure that all is right.

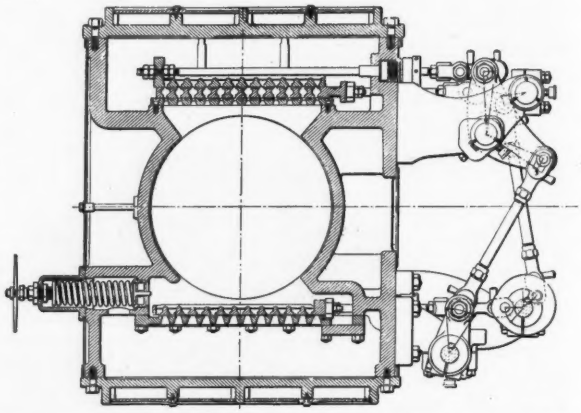


FIG. 4. ARRANGEMENT OF VALVES, VALVE ARMS, LINKS AND SHAFTS

In assembling the governor it is not absolutely necessary to follow the exact order of operations as I have given them, but the springs should not be put in before the other parts are assembled. One more point is to be noted: be sure that all of the lead weights are in place in the governor arms. It will probably be necessary to remove some of them later on, but not until it is certain that the speed of the engine is too low with them all in.

DISTILLED GOLD

INVESTIGATIONS of a French chemist show that gold in the electric furnace boils freely at a temperature of 2400 deg. Centigrade. In 2 or 3 minutes, it is said, from 100 to 150 grams of gold pass into the state of vapor. In condensing upon a cold body, says Harper's Weekly, this golden vapor forms filiform masses and cubic crystals. At its temperature of ebullition gold dissolves a little carbon, which, at the time of resolidification, is deposited in the form of graphite.

In an alloy of gold and copper, copper distils first. In an alloy of gold and tin, the tin distils faster than the gold, and, when a large quantity of these mixed vapors is taken, the tin burns on contact with the oxygen of the air, forming oxide of tin, colored purple by a fine dust of condensed gold. This is one method of preparing the color known as "purple of Cassius."

OCTOBER 6 TO 11, the Second International Congress of Refrigeration will be held at Vienna, Austria. At the meetings different committees will take up programs covering Gases and Units, Construction and Testing of Refrigerating Machinery, Refrigeration of Food, Industrial Refrigeration, Railways and Steam Ships, and Legislation and Administration. Special arrangements have been made in regard to rates going to and returning from these meetings and full particulars can be obtained from F. W. Pilsbry, 1660 Monadnock Block, Chicago.

HOW THE NEW CHIEF MADE GOOD

SETTLING THE ENGINE QUESTION

By Geo. H. Wallace

THE prediction of Chief Engineer Willard that there would be "an engine salesmen's convention around the old factory before long" was fulfilled much sooner than was expected. They came like trouble, not singly but by batallions, and sandwiched in between were representatives of generator manufacturers, switchboard companies, feed-water heaters, heating apparatus, feed-water regulators and about a dozen schemes for smokeless combustion of one kind and another, some of them impracticable—others worse.

But Willard let nobody come between him and his work. He kept right on the job all the time looking after building operations to see that the various contractors delivered the goods.

Fritz was in clover. Every salesman had, of course, a supply of cigars which finally found their way to Fritz, and for the time being he discarded his Missouri briar and fairly reveled in genuine Havana fillers grown in Wisconsin and made in Oshkosh.

"Fritz," said Willard one morning, as he entered his engineroom-office by the back door and found 4 salesmen awaiting him, "Fritz, they're coming pretty swift aren't they? How will we handle them all? Got any idea?"

"If Ay vos bossin' der chob, Ay vould gif dem rain checks or else numbers like der barber chop does."

The barbershop numbers seemed to strike the chief favorably, and passing the old box bed engine to his desk he tossed his hat on the table and said pleasantly:

"Good morning, gentlemen, who was here first?"

"I believe I was, Mr. Willard," said a salesman. "I am representing the International Pipe Co., and would like to figure on your requirements along the line of piping, headers for your boilers, etc., and radiation for the factory."

"Well, sir," said Willard with a smile, coming right to the point at once without mincing matters, "everything along that line has already been contracted for. And who was next?"

"I was the second man to sit in the game," said the belting salesman, catching the spirit of the occasion, "and I would like to look at your requirements on leather belting. Am I too late?"

"You are not." And the chief whirled around to his desk and consulted a memorandum book. "We will want about 300 ft. of 8-in. double leather belt," he read, "500 ft. of 6-in. double, same of 5-in. and of 4-in., and about 1000 ft. each of 5, 4 and 3-in. single leather and a few hundred feet of smaller sizes. Give me your figures and your guarantee."

"I'll have my sample case sent over here, Mr. Willard, and we will take the matter up fully—say at 11 o'clock. Does that suit you?"

"Perfectly," said Willard. "Next!"

"Anything doing in the pump line today, Mr. Willard?" said the third man with a smile.

"Absolutely nothing," said the chief, "for we have already purchased everything required in that line. And you?" to the fourth man.

"Have you bought your engines yet?" he asked.

"We have not contracted for them as yet," replied the chief. "What firm do you represent?"

"I am with the Oshkosh Engine and Machine Co., of Providence, N. Y., and we've got the best engine made—ab-so-lute-ly the best. Now, we don't believe in all this waste of metal in putting it all into a big frame that looks massive on the outside like other builders do. Neither do we fiddle away a lot of time on doubleports and removable bearings that are never taken out anyway, and solid end rods like some of these experimenters build. Now, there's that Kalamazoo engine. Say, but that's a rotten engine. Say, I was over there the other day and all they put in their engines is old stoves and similar scrap. I saw them machining the jaws of an engine frame by setting it on the floor back of a planer and fastening the tools to a planer bed beside it. And then there's the Siegel & Hooper company. I am told that they haven't got a boring bar large enough to bore a 24 by 48-in. cylinder without springing the bar 1/16 in. in the middle. We don't do our work that way. I saw a crankpin on a Rasper & Howell engine so much out of square that when the crank went over the centers you could see it spring the rod sideways and almost force the crosshead out of the slide! Fact!! No, we don't do that kind of a job at all.

"Then I met a fellow last week who knew a man whose wife's cousin was an apprentice at Chase & Ketchum Co. in Pittsburg and he says that he says that she says that he says that they have to send all their big work to outside shops to be machined and that they never run a line through any of their engines. That's what he said that she said that he——"

"By the way, sir, what kind of an engine do you build. I haven't heard a word yet as to what kind of an engine your firm builds, or whether you build any at all or not. All you have done for the last 5 minutes is to sit here and vilify other engine manufacturers, and you haven't said one single word about your own engine or your superior points or your economy, or anything else. Now, cut loose if you have anything to say—or else get out. I don't believe I care to have any dealings with an engine firm that will send out a representative that can't say anything or do anything but 'knock' on everybody else in the business."

"Say, you, Willard, do you know what I think of you?" said the agent in anger.

"Yes, I know exactly what you think of me, and it is like the overflowing cup of everlasting happiness to what I think of you. Now you'd better get."

And he got.

It took several minutes for Willard to regain his composure. This was the nearest that he had ever come to "flying off the handle" during the time that he had been with the firm. The months and months of actual open hostilities that he had gone through with John Gautelbeim had not the least effect on his quiet temperament; his encounter with the crooked boiler agent terminating with the forcible ejectment of the latter from his office had only slightly ruffled his temper. But when a professional knocker opened up his verbal batteries, patience then and there ceased to be a virtue.

In order to cool off as thoroughly and as quickly as possible he went out to the new boiler room where the boilers were already being installed. From there he passed on down through the tunnel where men were running a temporary steam main from the main header out to the several old slide valve engines so as to relieve the old and decrepit boilers that had strained at their rivets for years beyond number.

Finding everything there to his satisfaction he visited the old engines jogging along at 70 or 80 lb. pressure and mentally calculated the increase in horsepower that they would develop when the new boilers supplied the steam at 110 lb. and wondering if they would "stay on the job" till he got the new engines in running order and as he thought of new engines he decided to go back to his office and see if there were any more salesmen on the waiting list. And there were.

The stranger introduced himself and got right down to brass tacks at once. He dug down into his Boston bag and produced a book full of figures and facts to back up his statements. He was from a firm with whose engines Willard had not become acquainted through actual experience, but which had been extensively advertised in the mechanical press. The salesman got a general idea of the requirements and of the conditions to be met and then began to "frame up" engines to meet them.

DIMENSIONS OF CROSS-COMPOUND CORLISS ENGINES TO DRIVE DIRECT 240-VOLT GENERATORS. STEAM PRESSURE 165 LB. GAGE. BACK PRESSURE 26 IN. VACUUM HALF THE TIME, 3-LB. GAGE, REMAINDER. DOUBLE ECCENTRICS. CYLINDER TO STAND 2 REBORINGS

GENERAL SPECIFICATIONS	750 KW. ENGINE	450 KW. ENGINE
DIAMETER H.P. CYLINDER IN INCHES	20	16
" L.P. " " "	36	30
STROKE IN INCHES	48	36
R.P.M.	125	150
PISTON SPEED FT. PER MIN.	1,000	900
DIAMETER, STEAM PIPE IN INCHES	7	5
" H.P. EXHAUST " "	8	6
" L.P. INLET " "	12	10
" L.P. EXHAUST " "	14	12
SIZE OF RECEIVER	1.5 VOL. H.P. CYL.	1.5 VOL. H.P. CYL.
MATERIAL IN "	CAST IRON	CAST IRON
DIAMETER H.P. PISTON ROD, INCHES	4⅛	3⅞
" L.P. " " "	4⅞	4⅛
MAIN BEARING LENGTH & DIAM. IN INCHES	12 X 24	10 X 20
TYPE OF SHELL IN BEARINGS	5 PIECES	5 PIECES
KIND OF ADJUSTMENT	DOUBLE WEDGE	DOUBLE WEDGE
SHAFT DIAM. IN WHEEL & GENERATOR INCHES	15	12.5
GUIDES BORED V OR BAR	BORED	BORED
CROSSHEAD SHOES AREA APPROX. INCHES	11½ X 20	9½ X 16
MATERIAL IN SHOES	C.I. BABBITTED	C.I. BABBITTED
CRANK PINS	6½ X 6½	5½ X 5½
CROSSHEAD PINS	5½ X 7½	4½ X 6½
CONNECTING ROD LENGTH ℄ TO ℄ FEET	11	9
FLYWHEEL DIAM. IN FEET	14	12
" WEIGHT IN LB. APPROX.	45,000	22,000
" TYPE	BALANCED 2 PCS	BALANCED 2 PCS
GUARANTEED STEAM CONSUMPTION CONDENSING	12½ LB.	12½ LB.
" " " NON CONDENSING	17½ "	17½ "
HORSEPOWER AT FULL LOAD & PRESSURE STATED	1,125	675
GUARANTEED REGULATIONS NO LOAD TO FULL LOAD	1¼ %	1¼ %
APPROX. TOTAL WEIGHT OF ENGINE IN POUNDS	170,000	108,000
PRICE COMPLETE WITH HIGH SPEED FIXTURES & TRIMINGS, PRESSURE OIL CUPS AND PIPING NICKEL PLATED	$ 11,650	$ 8,800

First of all he advocated a high-speed Corliss engine of the releasing gear type with a high-speed governor, and guaranteed a regulation of not over one per cent from no load to full load, and a steam consumption of 12.25 lb. condensing and 17 lb. noncondensing, under the proposed conditions.

When asked upon what he based his guarantee he produced a book full of charts showing curves compiled from many tests which his firm had made under almost every possible condition.

"Now, in regard to your generator, we can cut a big hole in the price you would have to pay for it if installed on a slow-speed direct-connected engine, for the higher the speed, the smaller is the machine for a given electrical output, and that ought to receive careful consideration, for $1,000 is just as good to you as it is to any electrical company.

"Then, at a high rotative speed, it is not necessary to have a balance wheel of large diameter, which reduces the size of the shaft, size of the bearings and size of the frames, and in fact the size of every part of the entire engine. This means that you don't have to buy so much metal to get an engine of a given horsepower at high speed as you do at a lower speed—say 90 to 100 or even 110 r. p. m. And the larger the engine the larger the foundation and that is another increase in cost; to say nothing of piping, etc.

"Then again," continued the salesman, "the higher the piston speed, the lower will be your initial cylinder condensation, other things being equal, and the lower you can keep your condensation, the more perfect will be your cylinder lubrication, thus reducing friction and again cutting down on the cost of operation.

"If floor space is an object, we can put more horsepower in a given area than any engine built, and if you have the place already selected for your engine, figuring on large units, we can give you more room around them, or, if space permits, we can put—in say 4 units—in the same space that would be occupied by 3 large slow-speed Corliss engines of similar type, and still give ample space around them for proper care and attention."

"Well," said Willard, "those are very good features, no doubt, but will your valve gear stand the racket day in and day out?"

"Read this." And the salesman produced this letter:

"April 9, 1910.

"Gentlemen:

"Our engineer computed a few days ago how many revolutions one engine has run since you installed it 8 years ago this month, and we thought you would be interested to know that the grand total is the enormous sum of 303,264,000 revolutions. It has run on an average of 15 hr. a day, 6 days a week, and the load ranges from 75 to 120 per cent of the generator capacity. The engine, as you know, is 12 and 22 by 36 and runs 135 r. p. m. direct connected to an 800 kw. generator, and still has the same trip steels and knock off blocks that came with the engine, and they appear good for several years more. We have never had to rebabbitt a single

bearing and the crank brasses do not appear to be any nearer together than when new, while the dashpots are just as prompt as they ever were and the valve gear is just as near noiseless as it is possible to be. The engine takes an excellent card.

"Yours very truly,

_____."

"I'm not from Missouri, but I'm going over to see that engine," said Willard as he handed the letter back to the salesman, and as it was only a matter of an hour's ride on the train they went over. If the letter had created a friendly feeling in the mind of the chief, the engine itself fully convinced him. He studied over every feature of it intently and in silence.

"The shop shuts down this afternoon on account of the county fair, and if you want to see the inside of the cylinder after some 350,000,000 revolutions I'll take the head off for you," volunteered the engineer of the plant, and the opportunity was eagerly grasped by both Willard and the salesman.

That afternoon when the cylinder head was removed there was revealed the first cylinder the chief had ever seen—finely blued and highly polished like a plate glass mirror and not the least sign of a scratch. Willard was indeed surprised.

"How tight are that piston and those valves?" he asked.

Without a word the engineer handled the engine by hand skillfully and brought it back on the dead center and admitted steam in front of the piston. There was hardly a sign of vapor any more than what would be produced by a change in temperature caused by the engine standing idle an hour or so.

"That's enough," said the chief, and they went back on the next train.

"Fix me up a list of your general dimensions for 2 750-kw. and a 450-kw. cross compound engine to run under 165 lb. steam, under these conditions," said Willard, as he tossed down the list on his table. "I have to go out and look after my work for a little while, but will be back directly." Saying which he picked up his hat and disappeared.

The salesman dug down into his capacious bag and brought forth a lot more of data, with a slide rule and proceeded to calculate the approximate size, weight and cost of such an engine as would be needed to meet the conditions.

In the course of a couple of hours the chief came back expecting to find the salesman just fairly started on his task, but was surprised to see him listening to some German hair-raising engineering experiences as set forth by Fritz, while the latter smoked another "George Henry" cigar that was "for men only," occasionally laying his "snipe" on the head of the engine while he relinquished his narrative in badly sprained English long enough to fire up, pump up and oil up.

Willard got John Gautelbeim on the 'phone and requested him to come over, which he did.

A few little details as to oiling devices, terms of payment, etc., were thoroughly discussed; finally Willard said, turning to the general manager:

"Would you like to suggest anything additional to what has already been said and done, Mr. Gautelbeim?"

"Willard," said John—with great seriousness, "20 yr. ago I didn't know any more about an engine than Adam did about a bicycle and I've been getting 'no better quite rapidly.' If it suits you, it suits me, and I'll sign it and be done with it," and, suiting the action to the word, he affixed a signature to the contract that looked like that of John Hancock on the Declaration of Independence.

"Well, that's the last of the contracts, except the generators," said Willard as Fritz came up with an order to be signed for 10 lb. of waste. As Fritz went over to the storeroom for his waste his heart was as heavy as his feet.

"If dots der ladst kontract, den dats der ladst real cigar dat Ay gits. Affer dis Ay must put oop mit der rubber cigars in er calfskin wrapper what der poys gives ervay or schmoke my pipe or go mitoudt. Vell, such is life und it iss gittin' sucher und sucher!"

DRAGGING A ROAD ACROSS IOWA

ANY man who can transform an Iowa mud road to a nearly perfect highway, 380 miles long, at an estimated cost of building and maintenance for the first year of $3 a mile, has grasped a new idea in the matter of road building. That the road from Council Bluffs to Davenport is a success and is commanding the attention of the entire country and Canada, is shown not only by its splendid condition, but by the enormous mail which pours in upon the secretary of the River-to-River Dragged Road, which is Mr. Eichinger's official designation—without pay, by the way.

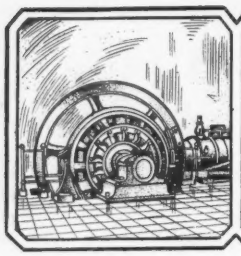
Once Eichinger hit upon the township unit, he promptly proceeded to interest the influential men of the country in the project—farmers, bankers, automobilists, country editors, clergymen, merchants, school-teachers, and scholars, all were pressed into service. Governor Carroll appointed commissioners for each county, every one of whom received a commission bearing the great seal of the State, with a lot of ribbon, and was altogether an imposing document. And these men served without pay.

Upon a diplomatic hint the townships of a county through which the road passed were formed into an organization like a company of infantry, with the "Special River-to-River Dragged Road Commissioner" as captain. He had his squads strung out along the road, and upon the word from Secretary Eichinger started them to work dragging the highway. The haughty owner of an automobile, perforce, hitched a drag behind his car and got to work. It did not take long to establish the fact that a motor-car could drag after a rain from 8 to 10 miles of the highway in an hour, thus leaving the road in excellent condition.

When the feminine portion of the community discovered that the dragged road meant more frequent trips to town, more visitors, and lots of touring cars whizzing by, they spurred the male laggards. Road-dragging parties became the vogue from the Missouri to the Mississippi. The old-time buggy ride, formerly a Sunday luxury, became an every-day occurrence. The farmer and his family started to talk motor-cars—and before they realized it they bought one. More than 8000 cars have been sold in the state this spring. Up to date 17,000 automobiles have been licensed by the state.—Stewart Ives de Krafft, in Harper's Weekly.

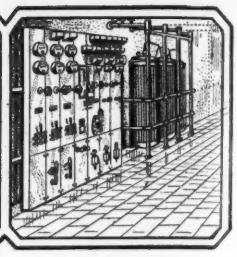
A BALLOON OMNIBUS carrying passengers from Lucerne to Interlaken, has just started making its trips. Fare, 2000 francs each; schedule time, 4 hr. each way. The company also insures the passenger's life for 50,000 francs; premium, 75 francs.

"MEN WHO possess ability are those who have studied to get where they are."—Chalmers.



Electrical Machinery

For Generating, Transmitting and Using Current



PROFIT AND LOSS

BIG RETURNS IN ELECTRIC CIRCUITS

By F. Webster

IT HAS BEEN SAID that anyone, not excluding a deaf mute, will prick up his ears and take notice when offered a "sure thing proposition" for doubling his money. As the electrical engineer can offer better than double, it might be of interest to some of the present day investors to study one of the old problems relating to capacity and inductance of circuits, this particular one giving over 5 to 1.

Thus, suppose that a certain circuit is arranged as shown in Fig. 1. This circuit is laid out so that it leaves the line at A, and has an incandescent lamp at B. Immediately below the lamp B, the circuit is divided at C,

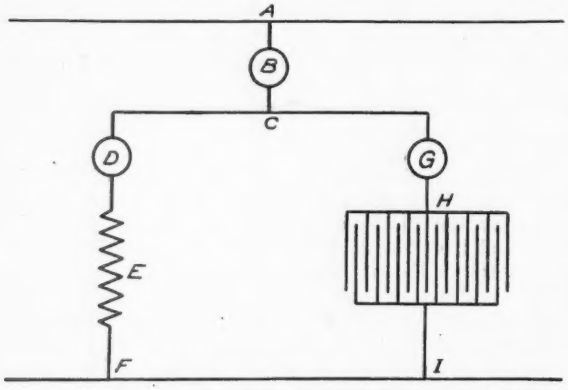


FIG. 1. CIRCUIT CONTAINING INDUCTANCE AND CAPACITY

one branch having an incandescent lamp D, and an inductive coil E, and joins the other line wire at F. The other branch leads from C and has an incandescent lamp G, and a condenser H, and reaches the line wire at I. The main line voltage is 550, alternating with a frequency of 133. The restistance of the incandescent lamps is 100 ohms each, the inductance of the coil E is 0.597 henry, and the capacity of the condenser is 2.49 microfarads. The arrangement is such that when 0.4 ampere passes through lamp B, there is approximately one ampere passing through the lamps D and G in the branches; that is, the sum of the amperes in the branches, or 2 amperes, is 5 times the current through the lamp B.

Several terms have been used in describing Fig. 1 that may be new to some operating engineers. While a thorough understanding of these terms as to their values and their relations to each other would require a special training in electrical engineering, yet the application of the principles involved is easily understood. A brief explanation of the meaning of each term is given in simple language below, and the reader, if he does not have an electrical training should take it for granted that the applications are correct. The article is written for the purpose of showing the unexpected conclusions which are sometimes arrived at when using alternating currents, and not for the purpose of giving a dictionary of electrical words.

The pressure of an electrical current is called its electromotive force or voltage, and it is represented by the letters e. m. f., and the unit as measured by switchboard instruments is called the volt. The voltage corresponds with the steam pressure of a boiler, while the electric current corresponds with the quality of steam flowing from it. The pressure does not depend upon the size of the boiler, likewise the voltage does not depend upon the size of the generator. The unit of electric current is called the ampere. Any wire or device for transmitting an electrical current has a resistance which tends to cause a loss of pressure; that is, the voltage grows less as the length of line increases. The unit of resistance is called the ohm. A piece of copper wire 1000 ft. long, and having a diameter of 0.1 in. has a resistance of about 1 ohm. In the formulas for working electrical problems, the resistance of the circuit is represented by the capital letter R.

Besides the resistance of the wire, it may be so arranged that when an alternating current is passed through it, the current will be choked back; that is, the current wave will lag behind the voltage wave and what would be its normal flow. This lag of current takes place when the wire is wound in a coil, and the effect is greatly increased by placing an iron core in the coil. The choking effect of a coil is called its inductance and the unit for measuring it is called the henry. The ordinary transformer has considerable inductance and causes the current to lag in the line. The henry is represented in formulas by the capital letter L.

For an alternating current the strength is continually varying and also its direction of flow alternates. Its strength starts at zero and rises to its greatest value, declines to zero and builds up to its greatest value in the opposite direction and then diminishes to zero. This series of wave-like operations is called a cycle, which is repeated continually. The method of designating the cycles of the current from an alternating current generator is to give their number per second or frequency, and the term is represented by the small letter n.

A condenser is a device made up of flat sheets of tin-foil, every sheet in the stack being connected to opposite terminals. The sheets are separated from each other by insulating material, as shown at H, Fig. 1. A condenser can be charged with a quality of electricity and then made to discharge itself. The farad is the name of the unit of capacity of a condenser, but as this unit is very large as compared with the capacity of the

ordinary condenser, it is customary to state the capacity in millionths of a farad, called a microfarad, the prefix "micro" meaning a millionth part. The farad is represented by J. The condenser causes the current wave to go ahead of the voltage wave; that is, it gives lead to the current. This lead effect is just opposite to the lag effect caused by induction and can be made to neutralize induction. A rotary convertor or a synchronous motor acts like a condenser in giving lead to the current in the line.

The method of computing the current that would flow through the circuit in Fig. 1 is by means of 2 formulas or rules. These formulas have been worked out in textbooks on electricity, and all that is to be done in the present case is to insert the values given in the problem and complete the arithmetical work. When the resistance of a lamp, and the amount of current flowing through it are known, the amount of loss of pressure in volts is found my multiplying the resistance by the current. Thus, the loss through the lamp B will be $0.4 \times 100 = 40$ volts, and the pressure left to force the current through either of the branches will be $550 - 40 = 510$ volts. The formula for finding the amount of current that flows through the left branch C F, where the current lags or is choked back by the inductance of the coil E, is as follows:

Square the inductance in henrys; square the frequency and multiply these squares together and the result by 39.48; to the result add the square of the resistance in ohms and take the square root of the sum; divide the e. m. f. by this root and the quotient will be the current in amperes.*

By putting the values of the terms in the problem in place of the names in the rule, it appears as follows:

$$\text{current} = \frac{510}{\sqrt{(100^2 + 39.48 \times 133^2 \times 0\ 597^2)}} = \frac{510}{508}$$

equals 1 ampere, approximately, which is found by performing the arithmetical operations as indicated.

To find the current flowing in the right hand branch, where the current gets ahead of the pressure caused by the condenser, use the following rule:

Multiply the square of the capacity in microfarads by the square of the frequency and divide 25,350,000,000 by the result; to the quotient add the square of the resistance in ohms and take the square root of this sum; divide the e.m.f. by this root and the quotient will be the current in amperes.†

And when the data of the problem is inserted in place of the letters, the formula has this form:

$$\text{current} = \frac{510}{\sqrt{\left(100^2 + \frac{25{,}350{,}000{,}000}{133^2 \times 2\ 49^2}\right)}} = \frac{510}{491}$$

Lag and the lead of electric currents can be expressed in terms of an angle, just as the eccentric on the shaft of an engine is set a certain angle either ahead or behind the crank position. Thus, in Fig. 2, suppose the line AC represents the direction of the current at a particular instant in the main line and through lamp B; then the current in the branch line CF of Fig. 1 will be behind CA, and that in CI will be ahead of CA. These angles between the directions of the currents are easily computed by the use of trigonometry. Those engineers not familiar with this branch of mathematics will have to consider the results only without reference to the method of getting them. It might be stated here, however, that trigonometry is a very easy, as well as a useful subject to learn.

The cause of the current in the 2 branches being much larger than that in the line is due to the lag caused by the inductance in the coil E, and to the lead caused by the capacity of the condenser H. The current in the branch with inductance E lags behind that through the branch with the lamp B by an angle whose tangent equals $6.28 \times$ frequency $\times$ inductance $\div$ resistance $= 6.28 \times 133 \times 0.597 \div 100 = 4.989$, corresponding to an angle of 78 degrees, 30 minutes. The values of angles corresponding to different tangents are given in handbooks. The current through the condenser H leads that through the lamp

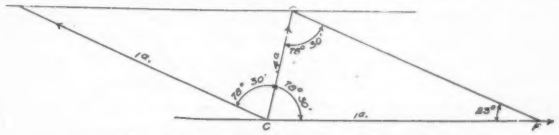


FIG. 2. PHASE RELATIONS OF CURRENTS

B by an angle whose tangent equals $1{,}000{,}000 \div (6.28 \times$ frequency $\times$ capacity $\times$ resistance$) = 1{,}000{,}000 \div (6.28 \times 133 \times 2.49 \times 100) = 4.8077$, corresponding to an angle of 78 degrees, 30 minutes. The difference in phase between the currents in the 2 branches is equal to the sum of the 2 angles computed above, or 78 degrees, 30 minutes plus 78 degrees, 30 minutes equals 157 degrees, and this angle is laid off as shown in Fig 2. The current flowing through the lamp B and the line equals the geometrical sum of those in the 2 branches; that is, its value will be represented by the length of the diagonal CA of the parallelogram constructed on the lines CF and CI in Fig. 2. The lines CF and CI should be of equal length and to any convenient scale to represent one ampere. The length of CA will measure 0.4 of CI, or CF.

Therefore, when the get-rich-quick scheme is worked backswards, as it always is sooner or later, generally sooner, the investor who has put in a lot, always gets in return what the combination happens to deliver, which is very little.

*In Short form:

$$\text{Current} = \frac{\text{e. m. f.}}{\sqrt{(R^2 + 39.48\ n^2\ L^2)}}$$

Where letters represent quantities as stated in the text.

†The short form is:

$$\text{Current} = \frac{\text{e. f. m.}}{\sqrt{\left(R^2 + \frac{25\,350\,000\,000}{n^2\ J^2}\right)}}$$

DIRECT CURRENT MOTOR WIRING

By C. J. McCarthy

IN cases where only one motor is used, wiring is of the simplest possible character, consisting merely of 2 continuous wires running side by side.

For exposed work, the wires may be insulated with rubber, slow-burning weather-proof covering or with rubber and braid. They must be carried on porcelain knobs or cleats not less than ½ in. from the wall or ceiling surface and 2.5 in. from each other, if the voltage does not exceed 300 volts. If it does, these distances must be increased to 1 in. and 4 in. respectively.

Cleats or knobs must be located at intervals not greater than 4.5 ft., except in the case of No. 8 or larger wire strung in unceiled buildings; these may be supported only at each joist, girder or other timber even though these may be located at greater intervals than 4.5 ft.

For all other classes of work only rubber-covered wire is allowed.

In conduit work it is preferable to run a single line of conduit and put both wires in the one tube; twin or duplex wires may be used and this arrange-

ment is much preferable mechanically. Moulding may be used only in open, dry places and for potentials not exceeding 300 volts.

The size of wire to be used for such an installation is readily determined according to the voltage

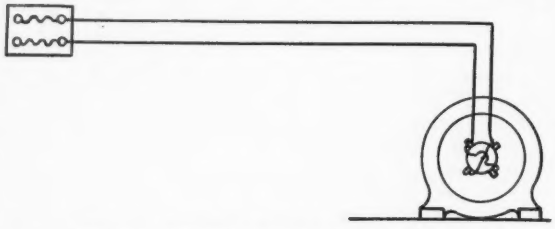


FIG. 1. WIRING FOR A SINGLE MOTOR

drop allowable and this is the only allowable basis even though a motor may be given its full load only once a week.

Multiple Circuits

WHEN an installation comprises several motors, a feeder should be run to a distributing point located as nearly equidistant, electrically, from the motors as possible and a panel board installed therefrom which should radiate individual sub-feeders, one for each motor, as indicated in Fig. 2. The main feeder wire should be of such size that the drop in it will be smaller than the drop in any one of the individual sub-feeders, so that the variations in the load of any

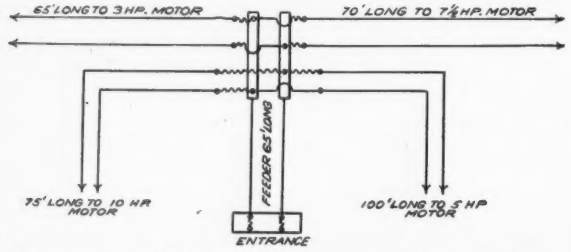


FIG. 2. CONNECTIONS FOR 4 MOTORS FROM 1 FEEDER

one machine will affect the speeds of others as little as practical conditions will permit.

Feeder Sizes

FOR example, suppose that 4 220-volt motors are to be installed of the sizes and at the distances indicated in Fig. 2 and the maximum drop at any motor must be within 3 per cent. For simplicity, it is advisable to divide up the drop in whole numbers, thus the feeder might be given 1 per cent of the drop and each subfeeder the remainder, not to exceed 2 per cent. If the motors are of ordinary efficiencies, the current carried by the feeder will be practically 100 amp. at full load. No. 2 wire will carry 105 amp. 66 ft. with a drop of 1 per cent, at 220 volts, so this would be the size of wire to use for the feeder so far as this drop is concerned; but allowance must be made for 25 per cent starting increase so that No. 1 wire must be used.

The 3 hp. subfeeder must carry 13 amp. 65 ft. with a drop not exceeding 2 per cent and the 5-hp. subfeeder to carry 20 amp. 100 ft. must be of No. 10 wire, the 7.5-hp. subfeeder 29 amp. 70 ft. must be No. 9 wire, and the 10-hp. subfeeder 39 amp. 75 ft. must be No. 7 wire.

In laying out wiring, moreover, the rule should be adopted of allowing in all cases a slight margin in either the distance or the current to be carried.

A BROKEN INSULATOR

By R. A. Cultra

I WAS on the last watch at night for a month. The station was connected through feeder lines to other stations which had machines running all night. The voltage on our board was very high after I had stopped our machines, but I thought nothing of it on account of power from the other stations. But every time I operated a certain line switch, which supplied current to a small company some 5 miles distant, the fire would fly and the switch burned so badly that it became necessary to renew the contact clips. These were ¾-in. bolts which passed through a 1.5-in. panel board with innumerable feeder lines and bus bars on the back.

A piece of heavy cable connected the switch and the bus bar and a piece about 2 ft. long connected the switch and the circuit breaker, which was above the

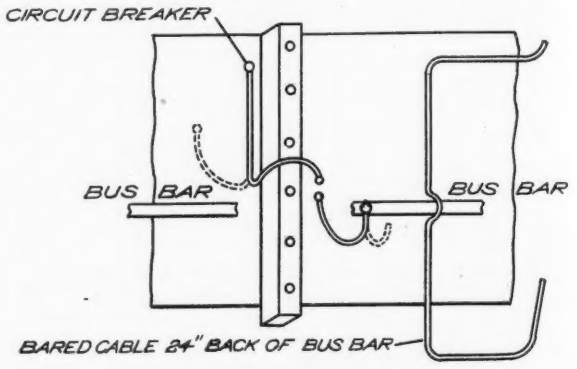


FIG. 1. CABLE CONNECTIONS TO SWITCH

switch on the next panel, the cable passing around the angle iron upright which supported the board, as shown in Fig. 1.

Back of the board about 3 ft. was a brick wall and down this wall through the floor passed several large cables, one of which had been bared of insulation a few days before to make a connection in making a test on a circuit, and the inspectors, in their haste to pick up their instruments when leaving, neglected to cover this bare cable with tape or mention it to the engineer. The arrangement is shown in Fig. 2.

I had just pulled out all the line switches on the board to make sure that no current was coming back and the board was dead.

The company on the line with the defective switch used a storage battery and had been notified to pull out its switch between the line and the battery. As there were no indications of any current on the board, I proceeded to disconnect the cable from the switch and bent it back, letting the end hang, but, as one is never safe from shocks with bare contacts, whether the board is dead or alive, I concluded to make sure it was out of reach of wrench handle, and proceeded to bend it up U-shape toward the circuit breaker.

It required more strength than I expected to bend the cable without loosening the nut at the circuit breaker, so I placed my right hand on the angle iron supporting the board while in the left hand I held the bare end of the cable. The board was supposed to be dead, that is, no current on it at all; but it was sometime before I had recovered enough from the shock to use either arm, especially the right one, and the job just had to be done before morning. I then pulled the

line circuit breaker, which took the current off this piece of cable and the other line breakers, as a precaution.

Thinking all was now clear and no leakage could come through to the lines or bus bars, I proceeded to disconnect the other cable and bend it back the other way, when to my surprise my elbow, which was bare, came in contact with the bare spot on the cable passing down the wall, and I got a shock again.

My right arm was almost useless from this second shock, but I could not stop, so called the oiler for assistance. The switch being disconnected I could not

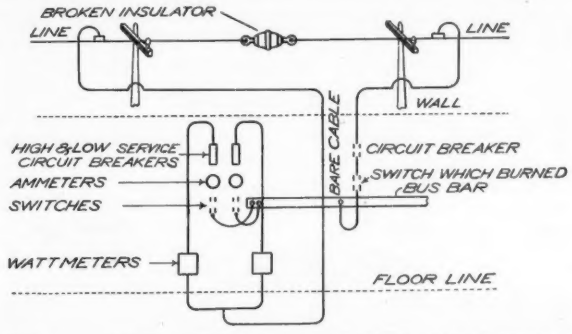


FIG. 2. BROKEN INSULATOR AND FEEDER CONNECTIONS

test out now to see where the current was coming from and the cables were now disconnected so I could work on the switch, as I knew what contacts were charged. After twisting off one of the copper clip bolts we succeeded in getting the old clip contact bolts out and the new switch put on.

I then proceeded to test for leakage. Putting in the switch I noticed nothing on the volt meters or lights, but taking a portable meter I found 450 volts on this line. I then accused the man in charge of the battery of falsifying, and continued to look for trouble. After putting in all the different line switches, one at a time, the lamps lighted up and showed the voltage apparently from the other powerhouses. Knowing the line this current came in on, I pulled the switch out. There was still potential on the board, 450 volts. The main volt meters were on the machines and none on the lines. I then pulled out all the switches, one at a time, until I reached the one on which I had been working, and one other which I will call No. 2, being on the cable that passed down the wall through the floor and up again to the switch, this being the bared cable. There was voltage on both of these lines, which should be dead. I traced both lines from the bus bars to the outside of the building, but could find no chance for a short circuit. So I reported the matter to the superintendent of wires.

The next night we made the same test again, the superintendent was as much puzzled as I was and concluded the trouble was not in the stations. When daylight came he started on what he expected to be a long walk, but had not gone far when he discovered that these 2 line cables were connected together at the ends with a guy or supporting wire which the linemen had used, placing an insulator between them. This system saved the trouble of stringing 2 long supporting or guy wires from the end of each cable to the pole beyond, the strain being equalized between the 2 ends. The strain on the insulator, however, was too great and broke it, letting the 2 iron contacts together, thus charging both switches on the board if either one was left closed.

A new and larger insulator was put in and the leakage stopped. It was known that more current had been going over the defective line than the consumer usually required, but was supposed to be used in charging the storage battery at the same time that the day load was running, which caused the switch to heat and turned it blue. I can only say that we were selling current through both of these feeders, with no meters or lights attached to them in the line of the newly formed circuit. The defective insulator and the charged switches, as well as the leakage in the revenue, would probably not have been discovered for sometime but for the accident of my getting a shock while repairing the switch. The 2 companies had been getting a large supply of current through one switch or the other without cost for some time past. The board is now tested regularly for leakage and other defects which may be found. Figure 1 shows the cable connections to the switch on the back of the board and Fig. 2 the feeders from the switches showing the broken insulator between the 2 lines outside the station.

FACTORY HEATING WITH WASTE HEAT

ALTHOUGH nearly every heating problem is different, the study of various successful installations for utilizing waste heat may often suggest features applicable to one's individual needs.

Last winter the Massachusetts Fan Co. completed and put into successful operation a heating plant for the Universal Carbon Co., of Ashland, Mass. This plant serves the 2-fold purpose of securing a temperature in the building of 70 deg. in zero weather and of taking the heat out of the carbonizing room and throwing it out of doors in the summer time. The buildings consist of a 3-story section with a 1-story ell, in 1 end of which is located the carbonizing room. The cubical contents is about 700,000 cu. ft. with 33,500 sq. ft. of exterior wall surface.

There are 8 carbonizing furnaces each 5 by 8 by 5 ft., in which oil is burned at a temperature of about 1,500 deg., with insufficient air so as to form lamp black. The tops of these ovens are protected by fire brick, but in spite of this a large amount of heat is radiated. Over each furnace a galvanized iron hood was installed which can be raised or lowered to suit operating conditions.

Each hood is connected by a 16-in. flue, equipped with a damper to a collecting main leading to a 100-in. blower, full housed, and top horizontal discharge, belt driven from a 10-hp. alternating-current motor, and capable of delivering about 20,000 cu. ft. of air a minute.

This fan discharges into a 40-in. distributing main leading through the 1-story section to the second story of the 3-story ell. Here it branches into a 25-in. flue for the first floor, 26-in. for the second, and 23-in. for the top floor. These flues have 6-in., 8-in., and 10-in. outlets arranged to distribute the heat where desired. All excess heat is delivered out of doors by a branch line. The installation has proved very successful.

NO ENGINEER should fail to cultivate intuition sufficiently keen to mark the policies of his employer and should fall in line with them at once, for otherwise he is likely to fall out of the force entirely.

IMPROVED RIDGWAY ENGINE

POSITIVE ACTING, WITH 4-VALVE.

DURING the past few years many important developments have been made in the design and construction of reciprocating steam engines. Prompted by the demands of the electrical industry, several builders of high-speed engines have produced the present day 4-valve, or so-called nonreleasing gear Corliss engine, with the economy of the releasing gear Corliss engine, and high rotative speed. The Ridgway 4-valve engine was designed after a close study of the strong and weak points of both types. To the designer who approaches the problem with an unbiased mind, the releasing gear Corliss will teach many valuable lessons, and the more careful the study of that type of engine, with its heretofore unequaled economy, the greater will be the success of the engine which results.

Steam Valve Gear

THE first feature which will be noted is the valve gear and in the mechanism which controls the steam valves will be found the principal difference between the older and newer types of engine. Referring to the illustrations, it will be noted that there is mounted on the

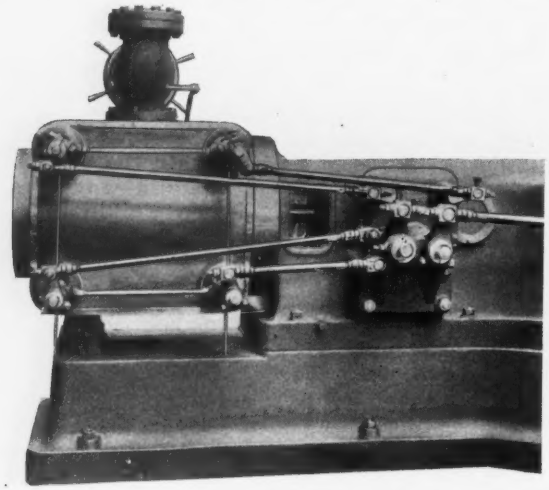


FIG. 1. COMPLETE VALVE GEAR OF THE RIDGWAY SIMPLE 4-VALVE ENGINE

bed a cast-iron case, called the "gear case," combined with the rocker bracket which supports the exhaust wrist plate. Three shafts pass entirely through the gear case and are supported by bronze lined bearings in each side of the case. The lower shaft is on the vertical center line between the 2 upper shafts and has mounted thereon 3 arms, 2 inside of the case and 1 outside. The outside arm is connected through the eccentric rod directly to the eccentric. The inside arms are the 2 sides of a single V-shaped casting, each side of which is composed of 2 parallel arms, through the outer ends of which passes a large pin, forming a bearing between them. Both of the upper shafts have 1 arm outside and 2 arms inside of the case, the latter being parallel, with a bearing between their outer ends, corresponding to and aligning with the bearings between the arms on the lower shaft. The 2 sets of arms are connected by links. From the outside arms on the upper shafts, reach rods extend to the arms on the valve stems.

The gear case is divided along a horizontal plane passing through the center of the 2 upper shafts, the 2 parts being bolted together by stud bolts and the joint made oil tight. By simply removing a few nuts, the upper part of the case may be lifted and access secured to all parts of the gear.

The accelerating gear is a system of toggle joints, by means of which the motion from the eccentric is so modified that the valves are at rest during the major portion of the unbalanced period, and opening and closing occurs when they have their maximum velocity.

Exhaust Valve Gear

THE exhaust valve gear is identical with that used on releasing gear Corliss engines. It is the usual wrist-plate motion, but instead of being mounted on the cylinder, it is located on the same bracket which carries the steam valve gear.

Cylinder and Valves

CONSTRUCTION and design of the cylinder and valves are quite clearly shown in the accompanying section. The cylinder is cast from a special mixture of irons, twice remelted and which is extremely hard, is

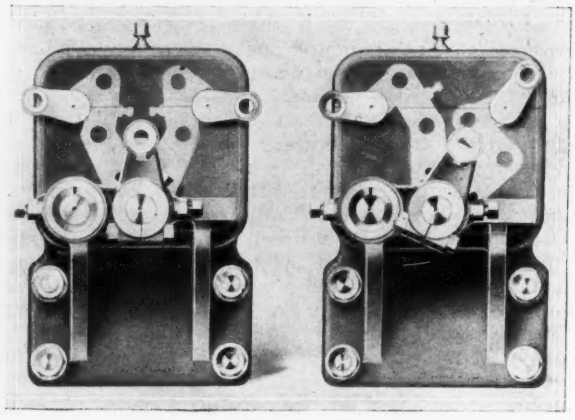


FIG. 2. STEAM VALVE ACCELERATING GEAR

covered with a planished steel jacket and the space between the cylinder and jacket is filled with high-grade nonconducting material. The loose head of the cylinder is fitted with a metal to metal joint, which is always tight without the use of gaskets, and a false head of neat design, with polished edges, entirely covers the head, the space formed between the 2 being filled with nonconducting material.

Valves are placed in the barrel of the cylinder in all sizes, their position being such that the ports are extremely short and direct and the amount of clearance is as low as quiet operation will allow. The steam valves operate in replaceable cages or bushings made from extra hard iron, these cages being ground on the outside and put in place with a heavy force fit.

After the cages are in place, they are ground true on the inside by a process which leaves a high polish, and the valves are ground to fit so that when new they are tight, and yet there is not the usual tendency to cut or wear.

Steam valves are double ported so as to secure a large port opening with a small movement of the valves, yet the design is such that there are only 2 edges past which leakage can take place. Also the Ridgway valve spans the shortest possible arc and any wear which can occur will make the valve tighter, since there is only one port and that is so located that gravity and steam pressure force the valve to its seat. The valve is symmetrical and can be turned to present a new wearing surface as often as desired, thereby greatly prolonging its life.

Except for reversibility, what has just been stated in regard to the steam valves applies equally to the exhaust valves. The metal in the valves is symmetrically distributed about any diameter, preventing warping and springing under the changes of temperature which constantly occur and their small diameter reduces to a minimum the unbalanced surfaces and the leverage by which the unbalanced forces resist the movement of the valve.

Reciprocating Mechanism

BOTH ends of the connecting rod have straps slotted out of the solid forging so that there is no strain on loose parts. The crosshead pin box is of solid phosphor bronze, while the crankpin box is of bronze, lined with babbitt, pened and bored; adjustment at each end is by the familiar vertical wedge, held by 2 heavy cap bolts.

The crosshead shoes are of cast iron, faced with genuine babbitt, and are of the cylindrical type. The upper shoe is bolted solid to the body, while the lower shoe is adjustable. Four hollow screws, without heads, are located inside of the 4 lugs on the body, each screw being turned by a blank nut on which are 2 projections corresponding to slots cut in the top of the screws. By turning the nut, which acts as a screwdriver, the screw forces the shoe and body apart or allows them to come together. Across the back of the shoe extends a heavy lug, projecting into a recess in the body; this lug holds the shoe central with the body and absolutely prevents the shoe from being stripped.

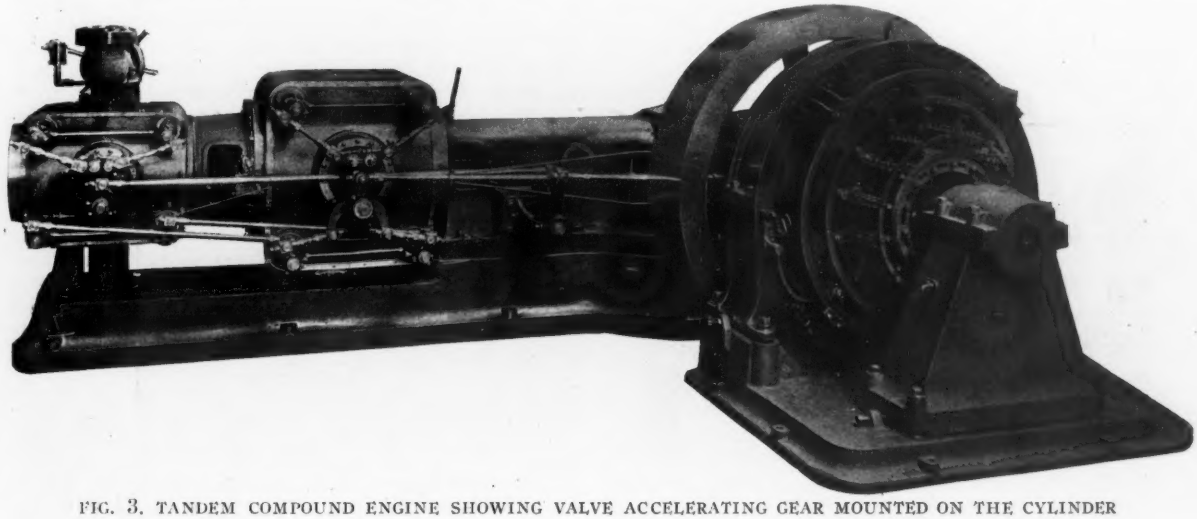


FIG. 3. TANDEM COMPOUND ENGINE SHOWING VALVE ACCELERATING GEAR MOUNTED ON THE CYLINDER

Valve stem stuffing boxes are always filled with a special metallic packing, which with ordinary care will last for several years and not leak.

Bed and Main Bearing

THE bed is of heavy design throughout, with the metal so distributed as to bring the heaviest sections in line with the greatest strains.

Unusually large openings are provided in both sides of the bed for packing the piston-rod stuffing box, and other openings, closed by light cast-iron doors, give easy access to the crosshead and pin. The bed is ordinarily mounted on an extra heavy cast-iron subbase, which extends under and supports the cylinder; with engines of the largest size, the bed is designed to go directly on the foundation and the subbase is unnecessary. In every case, however, a support is provided under the cylinder.

The main bearing on all sizes is of the quarter-box type, having shells lined with genuine babbitt, carefully pened in place and bored out in accurate jigs and therefore, interchangeable in engines of the same size. The top and bottom shells are also interchangeable and all shells may be quickly and easily removed without taking the shaft out of the bed. Horizontal adjustment is secured by a wedge, and vertical adjustment by drawing down the cap, which adjustments can be made while the engine is in operation.

The piston is a single hollow casting strongly braced by ribs and made as light as is consistent with strength. The special design makes the interior accessible for inspection, avoids the use of plugs and chaplets and also effectually prevents the occurrence of shrinkage strains. Depending on the size of the piston, 1 wide or 2 narrow rings of anti-friction metal are placed in the rim, which bear the weight of the piston and render impossible any cutting or scoring of the cylinder.

The piston-rod screws into the crosshead with a long fine thread and is held by a heavy jam nut, which is locked by a set screw in the crosshead body.

Shaft and Crank Disk

THE main shaft is a single forging of high carbon, open-hearth steel, extra large in the bearings, and proportionately increased in the governor wheel hub. Because of the large size of the crankpin and the shaft at the crank fit, the crankpin is cast solid with the disk. After the pin is turned and the shaft fit bored, the crank disk is forced onto the shaft under hydraulic pressure and is then returned to the lathe and a cut is taken off the lower edge of the disk. On the inside of the bed opposite the main bearing are surfaces machined true with the center line of the bed. If the distance between these surfaces and the disk calipers the same, after the

shaft has been turned 180 deg., as it did before, then the shaft is in line, provided, however, that both shaft and bed are level. The value of this feature for quickly testing the alignment will be recognized at once, since an engine which is not in line cannot be made to run quiet or cool.

Governor

IN the Ridgway governor a long inertia bar having weights at each end, is pivoted at the center on a roller bearing, the main pin of which is made large and heavy and is of steel, case hardened and ground. The inertia bar is lined with a single long bushing, which is also case hardened and ground, and the space between the pin and bushing is filled with rollers made of drill rod steel. This bearing, in all parts, is made to gage and with extreme care, resulting in the minimum of friction and wear, and while provision is made for occasional lubrication, it will go for many weeks without attention.

To the bearing hub is clamped and keyed the split eccentric. The eccentric strap, which is babbitt lined,

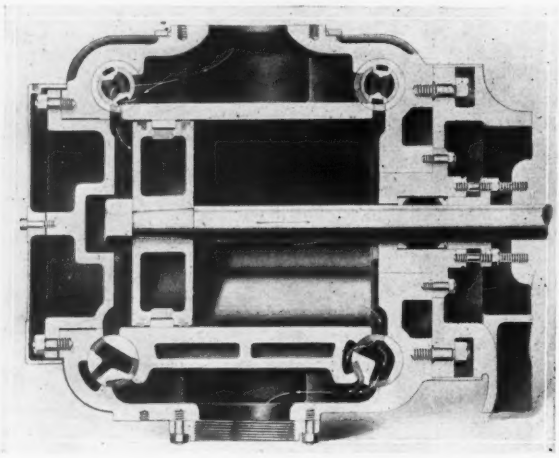


FIG. 4. SECTION OF CYLINDER AND VALVES

is also split and both eccentric and strap may be removed without disturbing the governor or the setting of the valves. Directly opposite the eccentric is a third weight, cast integral with the inertia bar, which balances the effect of gravity on the eccentric and through its gyroscopic effect opposes any tendency of the eccentric to vary its plane of rotation, and equalizes the strains on the roller bearing.

To the middle of one end of the inerta bar is attached a heavy coil spring and on an arm of the governor wheel is pivoted an oil dash pot, consisting of a cylinder with a loosely fitting piston and a piston rod which passes through both ends of the cylinder and connects to the inertia bar. Ample stuffing boxes, through which the rod passes, prevents the oil from escaping and a bypass with an adjustable opening allows the oil to circulate from one side of the piston to the other. By varying the size of this opening the sensitiveness of the governor may be changed.

The spring end of the inertia bar is the heavier and the speed of rotation depends entirely upon the equilibrium between centrifugal force acting on the inertia bar and the tension of the spring; while the actual movement of the governor parts is effected by the inertia of the weighted end of the bar. If the weight in the inertia bar and the tension of the spring are so adjusted that the centrifugal force increases faster than the tension of the spring, then the engine will speed up under load. In this condition the engine is liable to race, and it is to prevent racing that the dashpot is used.

It is possible to adjust the engine so that it will run faster under load than when running light and still have it regulate perfectly with no tendency to race; contrariwise, the governor may be adjusted to run slower under load than with no load. No difficulty is experienced in adjusting this engine to govern within a limit of one revolution and the instantaneous variation of speed when full load is thrown on or off is less than 2 per cent, while the action of the governor is unusually quick, the engine returning to its normal speed with a single vibration and within 2 to 4 revolutions, depending on the size of the engine.

Out-Board Bearing

IN harmony with the bed and subbase, the outboard bearing pedestal is built broad at the base and with heavy sections of metal in all parts. The bearing shell is lined with genuine babbitt, pened and bored, the lower half with a spherical bearing in the pedestal, while the upper half is held and adjusted by 2 set screws, with jam nuts in the cap; this makes the bearing self-aligning, since the shell can move in any direction. Horizontal adjustments of the bearing are made by set screws in lugs on the pedestal subbase; vertical adjustments are ordinarily made by placing liners under the pedestal, but if preferred, a screw adjustment similar to that in the crosshead will be furnished.

A special feature of this engine, which will be greatly appreciated by the operating engineer, is the ratchet turning-over device. By its use, one man can turn the largest engine off center with ease. When not in use, the device turns back out of the way of the governor wheel or any moving part.

Lubrication

TWO standard methods of lubricating this engine are provided. In the splash system, which is usually furnished, the crank pit is filled with oil, which the disk throws in an almost steady stream over the crosshead and guides, and oil from the upper guide is wiped off by the crosshead shoe and flows through passages and pipes to the crosshead pin. Pockets on the inside of the crank guard collect great quantities of oil, which are led through ample passages to the main bearing and by a centrifugal oiler to the crankpin.

The second system, furnished at a small extra cost, consists of a tank mounted on the subbase below the valve gear, containing a filter and a small pump driven by cam on the exhaust wristplate. All oil from the bearings flows to the crank pit, from which it is piped to the filter and is then pumped to a stand-pipe provided with an overflow. From the stand-pipe the oil is conducted to the various bearings, at which points the amount of oil flowing may be observed. When desired the valve in the outlet from the bed may be closed and lubrication will automatically begin by the splash system, for which every engine is arranged.

The extra good exterior finish of this engine is a profitable investment, as it is an incentive to keep the engine in good operating condition and makes it easier to do so. All castings, where not machined, are given 2 coats of filler, carefully sanded, after which 2 coats of special engine paint are applied. Exposed machined surfaces are highly polished. Each cylinder is finished with permanent nickel-plated indicator piping, which includes a 3-way cock, angle cocks and drip piping from the throttle and steam chest. This piping is so arranged that it can be used as a bypass to warm and

start the engine without opening the throttle, and the angle cocks are tapped so that either 1 or 2 indicators may be used.

Testing

AFTER passing through numerous inspections, the parts are finally assembled and the completed engine in erected on the testing floor where it is connected to steam and exhaust lines for a test run. This is a real test, lasting from 24 to 48 hr. under full and overload conditions, which are often far more severe than will ever be encountered after the engine is in actual service. Careful records of load, speed, steam pressure and general performance are made and a set of indicator cards is taken after the valves are carefully adjusted. Thus the performance of the engine when under test may be referred to at any time. Purchasers are requested to witness the tests of their machinery, if possible to do so.

Types

THE sizes of simple and tandem-compound engines range from 100 to 900 hp., and the cross-compound engines up to 1500 hp.

IMPROVING A HEATING SYSTEM

By John A. Carr

TWO boilers in the basement, one set close to the north wall, and one by the south wall, constituted the steam generating equipment of the system, which was direct and indirect, for heating a school building. Hot air furnaces had been used previous to steam, and they used the old hot-air flues and registers, set in the outside walls, for the indirect heat for the second floor and hall above; the result was cold instead of warm air in extreme weather. In the worst rooms they set a register in the floor in the corner of the room, which was accomplished by moving the stack in the basement into a corner and running a large tin conductor pipe from the stack through the room on the first floor to the register, and plenty of heat was then furnished.

There were no drips in any of the risers, the returns came down through the first floor, ran along the wall, and did not drop below water level until just before entering the boiler. The diaphrams were bent, dirty and useless, the draft they operated was heavy, needing 5 lb. to work it.

I put the diaphrams in order, put in balanced drafts, and a damper in each chimney flue; after getting these connected up there was a big difference in the way it ran. I could close up the south fire at 9 a. m. and keep the rooms warm all day; I had the boilers connected to run the north one only in spring and fall; one of the committee thought it was done to run them together in the winter. I tried it to please him, but it was not a success, nor economical.

The air cocks on the stacks and radiators were not automatic, so had to be vented. As the building had not been kept warm I studied hard to know the reasons why, and overcame them, most of them being easier to do than to explain. Egg coal was burned and I did not throw on 2 barrows full when one would do. The former janitor had only that building, I had 3 others, the farthest a mile away and steam heated. I also had the snow to shovel for the 4 buildings, and received $625 a year.

The armory where I have been since May, '94, has a 3 story head house of 18 rooms and basement, with a drill shed 68 by 125 ft., with iron frame work, open to the ridge; the original piping was a circulation of 5 1¼-in. pipes running the entire length on both sides, over the windows; these I had changed to circulations of 8 1¼-in. pipes put under the windows, extending the entire length of both sides, consisting of 4 independent sections on each side, returning into a 2-in. pipe. There are but few days when I cannot heat sufficiently with one side. I don't think the gage showed steam over half a dozen times last winter.

The boiler is a 40-hp. return tubular, with a Bannister shaking grate; there was an automatic regulator for governing draft that I cut out after a fair trial. I got it so 5 lb. would close it, and once closed it was closed for good, without pulling down the lever; then I put on a common diaphram, and connected it to the lower try cock, with a tee, and took the balanced draft from the side wall and put it in the center, under the ash doors; but better still, I use what I call a pin board; it is a short piece of board, having a shorter piece, with cleats of the same thickness nailed on the ends to set it out from the main piece which has holes for a wire nail bored about 1 in. apart lengthwise and is nailed to the wall under the rod of the damper in the flue. I set that, and my ash doors, and can keep my fire anywhere I want it. This device is not patented, so anybody is at liberty to use it.

They have given me 40 tons of what is supposed to be the Consolidated Co.'s Georges Creek coal, which is more than I have burned any year, while other armories this size burn 70 to 80 tons hard coal.

I am filling the combustion chamber, which is deep, with ashes to have it paved with slant back from bridge wall.

OILING UP THE "PLANT"

BACK of the throne we waited with palpitating hearts for our "debut" in opera. Our attention was attracted by the entrance of the great Caruso, accompanied by his valet, carrying a towel, a glass of water, and an atomizer. Then he began to "oil up." He "honked" the rubber bulb on the atomizer, and sprayed his throat and nose repeatedly. Then, "E—eh," he snorted. "Ay—ah, e—e," as he tried his voice. After this a gargle. His attendant gave him a small phial, which he tucked away in his bosom. Surely, we thought, he must be ready now; but no—one more gargle, and then dipping his fingers into the glass of water, he moistened his nostrils.

"Now, gentlemen, ready!" "One—two—three," commanded the stage-director; and we boosted Radames's chair with his precious load on to our shoulders.

Caruso pounded on the floor of the chair with his staff, and we halted. The king then rose on his throne and sang a few words of welcome. Another tap of the staff and we brought the hero down, slowly; one—two—three. Again lifting the ponderous but now empty chair to our shoulders, we marched off-stage. Then grabbing Amonasro (Scotti) by the arms we reentered, restraining him in his rush on to the stage.

As often as I have heard Caruso in Aida, I have never failed to see him "oil up." Even while the act is in progress, and he turns in despair after having Amneris thrust upon him as a wife, the tenor, in raising his hands to his head, takes from his bosom the little phial and swallows its contents surreptitiously—so far as the audience is concerned, though in full sight of the ballet and the "supers." Then, turning again, he is Radames, singing as fervently as ever. —Harper's Weekly.

THE MOUNTAIN FREIGHT TRAIN

By W. H. Wonfor

THE ENGINEER who sits in his office and orders his machinery to come by freight at the earliest possible moment, has small thought for that other engineer who sits around on the side of a hill, anxiously scanning the trail for the appearance of the pack train that he knows is coming with his

FIG. 1. ROADS ARE ROUGH AND NARROW

engine and boiler in small sections; devoutly hoping that the one section that is probably the key to the whole situation, is not lying at the bottom of a barranca in unrecognizable pieces by the side of a mass of flesh that was once a mule.

FIG. 2. LIKE PUZZLES WE WORKED OVER WHEN CHILDREN

In the out-of-the-way places of the world the work of the erecting engineer has a certain picturesqueness. His machinery comes in small pieces and, scattered around, looks like those puzzles which many of us worked over as children and wondered where the odd piece went.

The machinery that goes to an isolated place to develop motive or other power has to be sectionalized, as the roads are rough and narrow, and the capacity of the 4-footed freight cars is limited. The illustrations show the care that is necessary to secure bal-

FIG. 3. CARE IS NECESSARY TO SECURE BALANCE

ance so that the load will ride as steadily as possible and not overbalance the animal. It must also be tightly secured to the pack saddle, and it is often

FIG. 5. BOTH ANIMALS AND ATTENDANTS ARE A STRANGE LOT

necessary to make a special holder for some of the piece, as is shown under the smokestack sections in the illustration, Fig. 2.

When made up for the trail, the pack train may consist of a miscellaneous collection of boiler plates, piping and boxes containing the various bolts, screws, valves, etc., that are required on the job. It would be wise to give it room as it goes along, as the animals consider the trail theirs exclusively and have no hesitancy about brushing you out of the way with their loads or handing you a passing reminder in the way of a swift kick if the humor so takes them.

FIG. 4. PART OF A PACK TRAIN ON ITS WAY

Both the animals and their attendants are a strange lot. They are of all colors and sizes, and the men have a vocabulary that is both varied and picturesque.

Erecting of the boiler differs very little from the method used in more civilized places. In the place

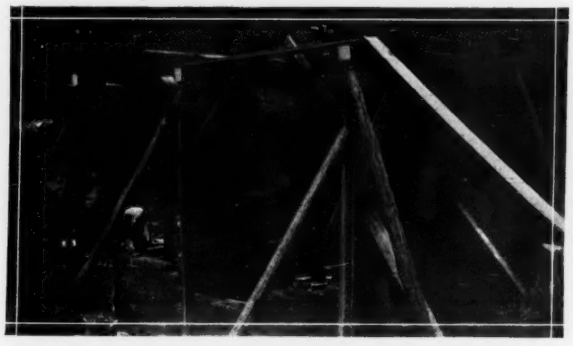


FIG. 6. ERECTING THE BOILER

illustrated the foundation is built of the old-time sun-dried 'dobe bricks instead of the smarter looking red brick found in most places that are supplied with more modern methods of freight facilities.

LUBRICATING PROBLEM SOLVED

A CERTAIN manufacturer had an order for a machine that included 3 hollow gun metal rollers, one weighing 1386 lb., the other 2 weighing 752 lb. each. These rollers are heated by gas to a temperature of about 700 deg., and it was found that any oil or grease would carbonize and cut the journals in a short while. In this predicament it was suggested that the builders of this machine write the Joseph Dixon Crucible Co. concerning the use of graphite on the rollers. This was done and proper suggestions were made for the use of Dixon's Flake Graphite to be used alone, and some months later the makers wrote the Dixon Company that the scheme had met with perfect success. Of how the graphite was applied, the letter speaks as follows: "The method of applying the graphite to the journals is very simple, the channels for conveying the lubricant to the journals are cut in the boxes about ⅜ in. wide and ¼ in. deep, one on top and one at a little above and on each quarter. Besides this, a spiral groove of the same dimensions is cut for about 2 turns, commencing at about 1 in. from the other end of the box and near the bottom. These grooves are half round in section. Into the top straight groove, a ½ in. pipe hole is drilled and tapped, a piece of ½ in. pipe screwed into this with a reducing socket on the top end to 1¼ in. pipe, a 1¼ in. nipple with a 1¼ in. cap complete the cup. A piece of 3-16 in. round C. R. steel with one end on the journal, with the other end up near the top of the cup, complete the device. The journals take about a dessert spoon full of graphite per day to each journal, the machine attendant occasionally removing the cap from the cup, churning down a little of the graphite with the 3-16 in. rod."

CAMPAIGNING FOR ROADS

I'LL never forget the night I called on the Widow Yarn. She owned forty acres on the main road which I hoped to have improved. In practically every house in the county I had been hospitably received because I was a human being. A pioneer citizen, member of the Good Roads Club, took me in a carriage to see the widow. "I'll watch the horses," this wise old citizen said.

"Mrs. Yarn, I believe?" I began, ingratiatingly, when the door was opened.

"Well," the person who stood there observed, "I've been here forty years; you ought to believe it."

"This," thinks I to myself, "is a strange place for curbstone humor." And then aloud: "I have been talking for good roads, madam. We have decided to run a rock road by here and as——"

"Who has decided?" This in the voice a conductor uses when he asks you how old your little boy is.

"Why," I stammered, "the Good Roads Club and——"

"I don't belong to it, do I? They wouldn't have a woman member, would they?"

"I'm sure I don't know. I have been chiefly——"

"Sure you don't," the Widow Yarn snapped. "You're chiefly concerned about taxing my forty acres into the county treasury without letting me vote on it. What right have you to come over here to build roads? Are you a road-builder? Did you ever build a road or pay for one?"

"Madam," I said, "you really do have a vote on this question if a road district is organized. You have forty votes—one for every acre you own, and——"

Her face lighted up with a light that never was seen before on human face, unless perhaps in riding on an old transfer or getting rid of a bad nickel. She opened the door wider—I had not been admitted up to that moment—and asked me to enter.

"You say I have forty votes?" she inquired.

"You have," I assured her, feeling like the bearer of good news.

"Well, glory be!" the Widow Yarn sighed, rocking herself comfortably. "Glory be, say I; I'll cast them all against your old rock road."—Charles Dillon, in Harper's Weekly.

GETTING ACQUAINTED

WHAT THE SLIDE RULE IS AND IS FOR

IT IS EASY TO SEE how the slide rule does it for, suppose that you want to multiply 2 by 3, you put the end of the scale C at 2 on scale D Fig. 1 and look up 3 on scale C; just under it on D you will find 6, the answer.

In other words we find the length that represents the product by adding together the lengths that represent the numbers. That is really all we need to know about it in order to use the rule except to remember that each time we get to 10 we start over at 1.

Multiplication

FOR instance if we want to multiply 2 by 8, set 1 of of scale C at 2 on D as before; but 8 on C comes beyond the end of D, so we should have to add on a new length to scale D. That isn't handy, so we just shove C over to the left until 10 comes where 1 was and assume that scale D has been extended. Then 8 on C comes over 16 on D.

Nobody will use a slide rule for such problems, but they show the method and are easily checked. Later we may see why; just now we are learning the how.

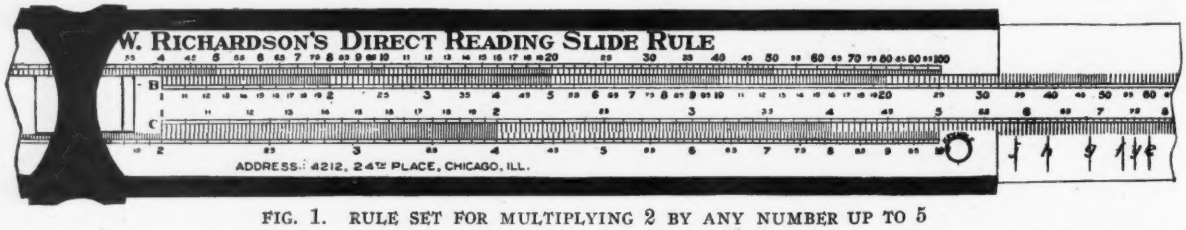


FIG. 1. RULE SET FOR MULTIPLYING 2 BY ANY NUMBER UP TO 5

If one number is between 10 and 100, the product is 10 times the rule reading as: 2×27=54 or 20×2.2=44. In this case, one of the numbers has 10 times the scale value, hence the product has 10 times its scale value.

Likewise, if both numbers are between 10 and 100, so that each has a value 10 times the scale value, the product will be 100 times the scale reading as:

20×13=260 or 20×31=620.

For numbers between 0.1 and 1, the values are 0.1 the scale readings and the products are accordingly, as: 2×0.3=0.6, or 0.2×4=0.8, or 0.2×0.25=0.050.

When it comes to handling larger numbers, common sense is the best index as to where the decimal point belongs, as: 2×226=452 and we know that 2×200=

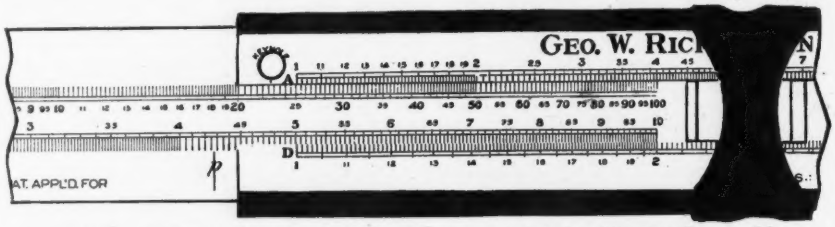


FIG. 2. SETTING FOR MULTIPLYING 2 BY NUMBERS BETWEEN 5 AND 10.

The actual operation of the rule becomes one of adding or subtracting lengths which represent members, and we could do it with only one scale, but it would be longer and more trouble. If you wanted to lay off 2 1-16 in. plus 3 5-32 in., you would lay off the 2 1-16 with a rule, and beyond that the 3 5-32 and measure the whole length; all with one rule. But, if you had 2 rules, you could put the end of the first at 2 1-16 on the second and under 3 5-32 on the first you would find 5 7-32 in., the correct length, without any laying off of distances.

So it is handier to use 2 scales on the slide rule and not be obliged to lay off distances and measure the total.

Decimal Point

IF YOU study Fig. 1 you will see that 2 may be multiplied by any number up to 5 with that same setting, and remembering that, so far as figures go, 2×3.5 is the same as 2×.35 or 2×35, and that the decimal point is all that changes, we can multiply 2 by any number whose first figure is between 1 and 5.

Thus to multiply 2 by 2.5 we find under 25 on C, 5 on D and if it were 2×25 the answer would be 50 or for 2×0.25 the answer would be 0.5. If both the numbers multiplied are between 1 and 10, the slide rule gives the value direct as: 2×1.5=3; 2× 3.8=7.6; 2×4.7=9.4.

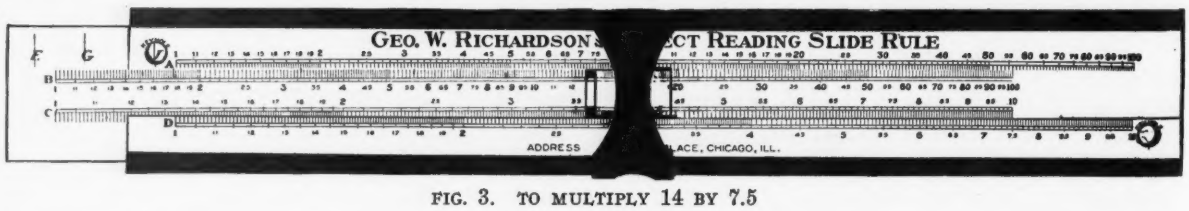


FIG. 3. TO MULTIPLY 14 BY 7.5

400 so that the 452 must be a whole number. With 20×37.2, the reading is 7440, and 20×30=600, hence, the product must have 3 figures before the decimal point and be 744.

Total Pressure

SUPPOSE that it be required to find the total pressure on a plate 14 by 7.5 in. carrying 123 lb. a sq. in. First, to find the area we have 14×7.5, and setting 10 on C to 7.5 on D we find 14 on C and under it is 105 on D so that the area is 105 sq. in. Then to get the total pressure we have area times pressure per square inch or 105×123; set 1 on C to 105 on D and under

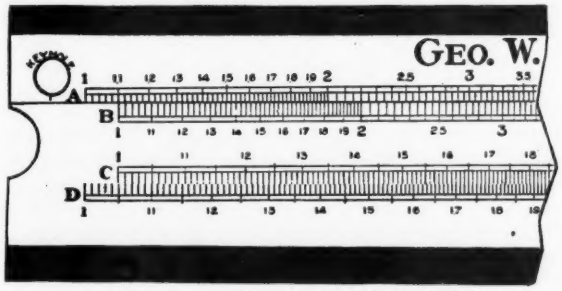


FIG. 4. MULTIPLYING 105 BY 123

123 on C we find 1291. As the product must be somewhere near 100×123 which would be 12,300, the answer is 12,910 lb. total pressure.

Accuracy

HERE comes in a question of accuracy which we need to understand. Multiplying 105 by 123 by arithmetic gives 12,915, or an error of 5 in 12,000 and that is near enough for any problem in engineering. When reading at the other end of the scale between 9 and 10, an accuracy of one in 1000 is as close as can be gotten, but even that is near enough for all practical purposes for it is only 0.1 of one per cent error.

scales are all that really count as the runner is simply a convenience in finding points on the scales.

For instance if it is desired to multiply 375 by 16.8, set 1 on C to 375 on D Fig. 5 and set the left hand line on the glass to 168 on C. The product is at the end of this line on D or at 630 and as 300 times 20 is 6000 the product sought is evidently 6300.

Division

DIVISION is the opposite of multiplication and on the rule it is taking away from the length representing the dividend that representing the divisor, the space left representing the quotient. To divide 35 by 25, using the A and B scales, set 25 on B under 35 on A, Fig. 5, and over 1 on B will be found 14 on A which is evidently 1.4.

Required the gallons of water in 26 cu. ft. As 1 gal. is 0.133 cu. ft. divide 1 by 0.133 and multiply by 26. To do this, set 133 on C to 1 on D, Fig. 3, and under 26 on C find 195 on D. Note that in the upper keyhole, J is set to the index mark. By referring to the back of the rule it will be seen that for key J, opposite any number of cu. ft. on C will be found the corresponding number of gallons on D.

Current of Lamps

ONE more problem; what is the total amperes current for 20 lamps each of which takes 54 watts at 110 volts? Total watts will be 20×54 so set 10 on C to 20 on D and under 54 on C find 1080 on D. Amperes equals watts divided by volts, hence, divide 1080 by 110. Set 110 on C to 1080 on D and under 10 on C find 9.82 on D which is the total amperes current. In multiplication, the answer is found under the multiplier; in division, the answer is found under the end of the slide, either 1 or 10 as the case may be.

Examples for Practice

PRACTICE on different examples in multiplication and division until the processes are entirely familiar and the method of finding position of the decimal point

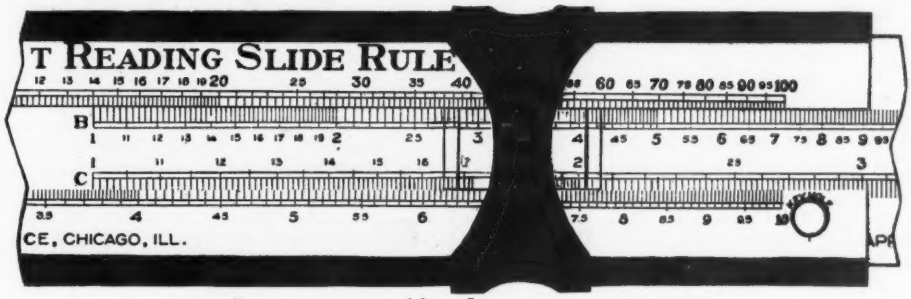


FIG. 5. TO MULTIPLY 14 BY 2 ON THE A AND B SCALES

Upper Scales

THE upper scales A and B are like the lower scales C and D but are half the length so that the accuracy of reading is half as great. For this reason it is better to use the C and D scales for ordinary multiplication and division. The right hand ends of the upper scales are divided the same as the left hand ends, but are numbered from 10 to 100 to indicate that in passing the 10 of the scale towards the right we add one figure to the whole number in the product.

All divisions of the scales are by tenths, but where a line at each tenth would make too many to be read easily, every alternate tenth mark is omitted.

Use of Runner

FOR the sake of clearness we call the main part of the rule the stock, the sliding scales the slide and the piece which carries the glass index the runner. The is clear. Then we shall be ready for the next step. Following are some practical problems:

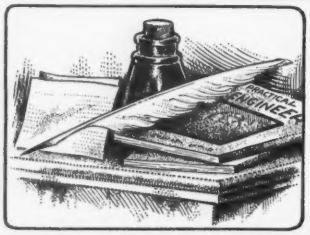
1. How much steam used an hour by an engine indicating 273 hp. and taking 18.3 lb. of steam per hp.-hr.?

2. What is the strength of a stay having an area of 0.7854 sq. in. made of steel whose tensile strength is 11,000 lb. per sq. in.?

3. How many amperes from a dynamo which is delivering 229,000 watts at a voltage of 525?

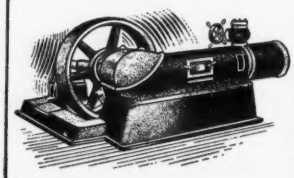
4. What efficiency for a pump which raises 11,300 lb. of water a minute through a height of 73 ft. and shows 32.2 indicated horsepower in the steam cylinders?

Operations and answers will appear in the October issue.



Letters from Engineers

Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



A BROKEN PISTON VALVE

ARE their any conditions under which an engine with a shaft governor could run away? This was a question asked by a Massachusetts examiner when the writer was before him for a first-class license. The answer was given in the affirmative, although up to the time of the accident described here I had never heard of an engine with a shaft governor running away, and, having received a black mark on the answer, I began to think I was wrong, as no engineer I knew could advance any theory to prove my statement.

It was possible that anything made by man can break and so it happened in this case with a small cross-compound Armington & Sims center-crank engine. It was belted from the governor pulley to a Thompson-Houston arc machine and from the flywheel on the opposite end of the shaft to a 60-kw.,

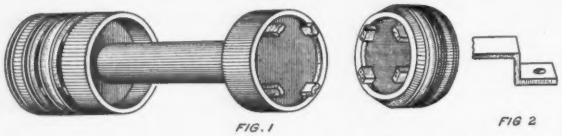


FIG. 1 FIG 2

FIG. 1. PISTON FROM ARMINGTON & SIMS ENGINE WITH END BROKEN OFF

FIG. 2. BROKEN CLAMP FROM THROTTLE VALVE

1100-volt alternator. The engine ran at 292 r.p.m., and was connected to the end of a 16-in. steam main in the engine room; 6 engines were connected to this main. The large engines were 2000 hp. Corliss and a 1000-hp. Green, both compound and all running condensing. The compound Green engine was often overloaded when running alone on the railroad load. The boiler would prime frequently and the water would be carried over into the engines. When the boilers nearest the small engine were in service this engine would often slow down in speed until the drips had been opened and the clearances freed from the water.

There had long been noticed a rattle and clatter in the throttle valve, but the chief declared it to be caused by the priming and nothing was mentioned further until one day when I took the watch. I was warned to look out for the small engine as the priming of the boilers was causing it to hammer badly. Hardly had the warning been given when a loud racket brought us to the engine. I suggested that the valve was out of order, but the chief persisted that the noise was from water in the cylinder and again reprimanded the fireman, who of course protested his innocence. After 2 hr. the engine again set forth a series of detonations. Another unit was started and the excitement began on closing the throttle valve, after the load had been shifted to the second machine. The engine instead of slowing down began to race. The throttle valve disk was gone off the valve stem and it was too late to shut the condenser valve. The belts were racing half their width over the edge of the pulleys when with much difficulty the stop valve on the steam pipe was closed. The engine slowed down some in speed but did not stop. Finally the condenser valve was closed and the atmospheric valve opened for the exhaust. Then the engine stopped.

Removing the bonnet of the throttle valve we found that the disk had been held on the stem by 2 angular clamps, as shown in Fig. 2, which had been fitted into a recess in the end of the valve stem and were attached to the disk by a single screw in each piece. The screw had come out allowing the disk to drop from the stem. The clamp being carried into the steam chest through the port with the steam, was caught by the valve when exhausting and still traveling forward, thus breaking off the back end of the valve which fell in the end of the steam chest, partially flatwise. It was struck by the remainder of the valve in its travel, causing the noise until it had been straightened up flat against the steam chest head, when it cleared the main portion of the valve in its travel and the noise ceased.

This being a compound engine running condensing, the condenser was practically running away with the engine after the load had been shifted to another machine. Having found the clamp, the disk was replaced on the throttle valve stem, the old piston valve removed and an old one, although much too small for the bore in the steam chest, was used until an end piece could be made and the valve replaced. Fig. 1 is a cut of the broken valve. Had the throttle valve been examined to determine the cause of the rattling, the piston valve, no doubt, would not have been broken. This valve exhausts through a 2-in. pipe connection in the center, lengthwise, which holds the 2 working ends together as one valve.

On another occasion a piston valve of this type separated in the center, where the end valve portion is screwed on to the pipe, the thread, having become loose, had worn until the pipe pulled out of the end allowing the steam to blow through to exhaust while the exhaust port was open. No damage was done in this case and a piece of pipe was cut the right length and put in and adjusted to the length between the ends.

R. A. Cultra.

WATER SOFTENING

NUMEROUS articles have been written on the feed water question and I would add a few suggestions. Makers of feed water softeners advance rightly the claim that they save the engineer the trouble of cleaning foreign matter out of the boilers as well as giving better economy. The matter of cleaning boilers does not appeal to the superintendent or manager so much as reduction in coal costs.

Feed-water softeners always give good satisfaction if they are given proper attention. Taking a clean boiler with furnace temperature of 1800 to 3000 deg. F. and steam temperature of 380 deg., the plates will be at about 400 deg. Now if the boiler is coated with ⅛-in. scale and the same quantity of heat is absorbed by the scaled surface as through the cleaned, the difference between the fire side and the scale side will be 350 deg. or the plate will have a temperature of 730 degrees.

After the boiler plate reaches the temperature of 600 deg. it loses strength rapidly. It is well understood that a boiler contracts when the fire door is open. A clean boiler contracts about 1/90 in. in 8 ft. producing a strain in material of 1.5 tons per sq. in., while the scaled boiler will contract 1/6 in. in 8 ft., producing strain of 22 tons per sq. in.

Evidently feed-water softeners and automatic stokers are agents in prolonging the life of steam boilers and giving a reasonable factor of safety.

Another thing which gives trouble in boilers is air in the feed water. On a certain United States battleship there was trouble with the boilers and the makers advised keeping oil and air out. The air which comes in with the water attacks the plates, causing rust and corrosion, and it may be shown that each cubic inch of oxygen coming in with the air is capable of reducing 0.84 of a grain of iron into rust, or that the free oxygen found in each pound of pure feed water carrying its normal amount of air is able to dissolve 0.154 grain of iron or 1.5 grain per gallon of water.

If this action goes on without hindrance, there will be enough eating away of plates to amount to 2/3 lb. for each 1000 hp.-hr. of service of the boiler. Owing to rapid circulation, however, the incoming water is whirled to the surface and a quantity of the oxygen passes over to the engine, although enough will remain to satisfy most engineers. G. Wetherbee.

DUTY ON SHIPBOARD

ABOARD a man-of-war machinists have all the engines to look after and operate; the machinery is divided up, and a machinist is in charge of a division or "station," as it is called in the navy.

My station consists of the ice machines and all deck machinery such as anchor engines, winches, steering engine and sounding engine. I also have all the steam-heating lines and radiators. As this is a warm country we seldom use the heating service, but we make a trip to Japan about twice a year and the climate is cooler there.

The ice machines are my pets, and I watch them very carefully. We have the Allen Dense Air Ice Machine No. 2, one on the starboard and one on the port side; I carry 240 lb. with 70 lb. on the expansion cylinder. Pipes from the port machine go direct to the cold storage and return to the machine, while the starboard machine pipes go direct through the icebox and return through the scuttle butt.

The circulating pump has been taken off and we get our circulating water from the flushing pump; it is first pumped through the machines and then returns to flush the crews heads down. I can produce more refrigeration from the port machine than I can from the starboard machine; why is it?

The warrant machinist tells me that the air returns quicker on the port machine than on the starboard machine, hence, the air is already cooler at the start; but what I cannot see is this—the return air, no matter how cold it is, all has to be heated again in the compression and cooled all alike by the circulating water. How is it then going to be colder after expansion than the other machine?

I like the work in the navy, but it is lonesome here on this island, we are laying at Guam. I would like to hear from readers of Practical Engineer, I mean a heart to heart talk; better yet, if you will all send me the price of a few postals, I will send you postals from different ports I visit. I will be only too glad to help pass the time away. A. Mellien,

U. S. S. Supply, via San Francisco, Cal., Guam, M. I.

INCIDENTALS OF THE FIRE ROOM

THE fireman reported that one of the boilers was not getting water; the trouble was immediately located at A in Fig. 1; the collar on the valve stem had become detached, thus permitting the stem to turn without effecting an opening. The check valve being in good

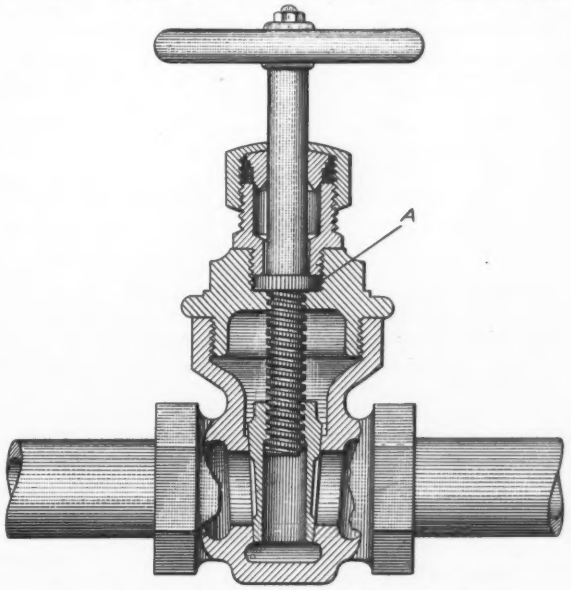


FIG. 1. VALVE WITH LOOSE COLLAR ON STEM

condition, the defective valve stem was replaced by another that happened to be on hand and a shutdown of the boiler was avoided.

With the continued use of a worn tube brush it is evident that the tubes are not thoroughly brushed

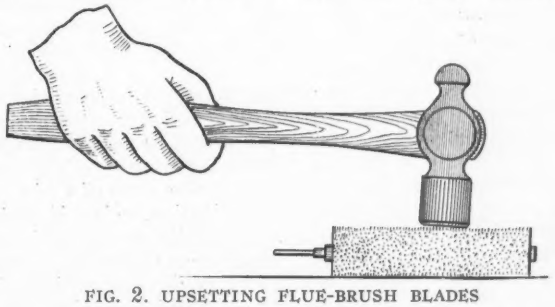


FIG. 2. UPSETTING FLUE-BRUSH BLADES

clean, and when a new one is procured it is difficult to get it through the tubes. If an emery wheel is at hand, the new brush is usually trimmed down enough to go into the tubes, with the result that its usefulness is no more than the old brush. A more simple and effective way has been devised, as illustrated in Fig.

2. By placing the brush on the stone floor, or any hard place, tapping its entire surface thoroughly with a hammer offsets the blades the required amount, and in time they will tend to resume their original position.

Jas. G. Sheridan.

WHO WAS TO BLAME?

VARIOUS arguments, pro and con, in regard to the duties, hours of labor and relations between the chief engineer and his assistants, which have recently appeared in the engineering press, bring to mind an occurrence in a large plant, located in a western city, where the writer was on a business visit at the time it happened. In this plant is a chief engineer with perhaps 20 running men. The plant operates 24 hr. a day and 6 days a week, making 2 12-hr. turns with a 24-hr. watch each alternate Sunday.

Among the running engineers was one who in all his years of service had never asked for or received a vacation or lay off. The long hours and constant grind, however, got the best of him at last.

As a matter of necessity and not from choice he was compelled to ask for a respite of 2 or 3 weeks in which to get back into physical condition.

When this request was put up to the chief it was met with a curt refusal, the chief saying he could not go out and lasso an engineer and drag him in every time somebody wanted to rest. Whether it was the refusal, the manner thereof, or merely the need of a "bracer," I was not able to find out, anyway the running engineer got on a glorious toot. The can was duly attached and a new man put in his place. Whether the chief secured him in true western cowboy style, or by the ordinary procedure matters not.

The engineer who was discharged had an excellent reputation, both as to ability and sobriety up to this time. The chief's standing in the community was of the best. Who was most to blame? The runner for working so long without a rest? The chief for his insulting refusal? The runner for getting drunk? The chief for his shortsightedness in not being able to tell when a faithful assistant needed rest? Or is it the system which makes it necessary for some of the men who fill the most responsible positions in our plants and factories to spend more than half their time at work? Traveler.

OHIO STATE LICENSE LAW

I BELIEVE the license law in the state of Ohio regarding the operating of steam boilers and engines is in a very crude state. Under the present system, a man with a third-class license has the same right and privilege to operate any plant that a man with a first-class license has.

The law requires a person to have 1 yr. experience as an oiler or fireman to be qualified for examination for an engineer's license; if he passes 60 per cent of the questions he is given a third-class license, which entitles him to operate any plant in the state of Ohio.

That is the extent of his examination, unless if at the end of 2 yr. he wishes to raise his license to a higher grade, he takes another examination; if he passes 70 per cent, he is issued a second class license, which will not entitle him to take charge of any larger plant than his third-class license did. After he has operated with the second class 1 yr. he is entitled to examination for first class, which, after he gets it, is no better according to law than the third class was.

Lots of young men get their third-class papers and knowing that their third-class license is just as good as a first according to law, they stop studying, while some others who are more progressive, continue studying, buying books and gaining knowledge, qualifying themselves for better positions, but what better are they according to law? Not any.

Take our schools, if a high school girl wishes to teach she takes her examination; if she passes, she gets a certificate good for 1 yr. She is given a position teaching a lower grade class. She knows, if she wishes to continue teaching another year, she must study for another certificate, which, if she passes a high enough grade will allow her to teach for another 2 yr. instead of 1, and every time she is examined and betters her certificates she is allowed to teach for a longer period between examinations, up to 5 yr. and is qualified to teach a higher grade.

By having to be examined at stated periods, they have to study, which keeps them posted on things outside of their little class. The consequence is, they are qualifying themselves to teach a higher grade, making better teachers for the children and demanding more respect and esteem from their parents.

I believe the law governing the operating of steam boilers and engines should be along the same lines. When a man passes his first examination by standing a certain per cent, it should entitle him to operate for 1 yr., at the end of that time he shall be re-examined; if he passes another given per cent, it will entitle him to operate for 2 yr. and so on up to 5.

In that way every engineer would become better posted, be worth more to his employer, which would eventually mean more pay for his work, and would grade us according to our knowledge and experience.

D. Rounds.

A BIG LIFT

AMONG the practical letters in the August issue is an excellent article relative to the lifting power of a water pump which reminds me of a case related many years ago by a fellow machinist during one of our noon-day experience meetings in a Philadelphia machine shop, and in which one of the owners would frequently take part.

This particular day the subject was water pumps and resourcefulness required in cases of emergency, and among the various experiences was one by John. He said he was called down to Jersey to fix a steam pump that the parties had just installed, but which wouldn't lift water.

He found the pump in good shape, but no water, and upon measuring the depth of the well found it was 37 ft. from top of water to pump; but, he said, he got the water. Well, how did you do it? was asked. "Why, I just put in 2 extra vertical checks, filled the suction pipe and went ahead. You see when the pump drew the water to the first and second check it couldn't get back and had to come up."

We all knew that Jack was a good workman, and also knew that he was one of the charter members of the Annanias club, so we all smiled a broad smile and let it go at that. W. S. Luckenbach.

BATTERY KINK

HERE is a new electrolyte found in every place where coal is burned and which is not down in any of the books. Take flue dust from the front of a return tubular boiler or from the base of the chimney and mix this with water to a paste of the consistency of a heavy cream. Fill the jars ¾ full and put in the carbon and zinc; you will have a battery that will work the same as if the electrolyte were salamoniac solution.

This may look like a joke, but if you will try it you will find these statements are correct. I am now using a battery which registers 1½ volt and works entirely to my satisfaction. When the battery gets dry add some more water. D. W. Etchings.

VALVE ADJUSTMENT

IN regard to what change L. A. C. should make to get a better diagram, I would suggest in the first place that he has too much compression on the head end; to remedy this adjust the exhaust valve so it will close a little later. By making this change it will let more steam pass into the exhaust pipe before the valve will close. He has unequal cutoff. The cutoff is too early on the crank end, and to remedy this he should adjust the cutoff rod that runs from the governor to the admission valve so the crab claw would unhook from the dashpot rod later in the stroke. By doing this, the engine would take steam longer in the stroke, which would equalize the cutoff.

It appears to me that the admission is a little late on the crank end; to remedy this he should adjust the valve rod that runs from the wrist plate to the admission valve on the crank end so that the admission valve would admit steam to the crank end of the cylinder before the beginning of the stroke. W. D.

DIDN'T KNOW IT WAS LOADED

ABOUT 4 months ago our machine blacksmith had occasion to remove a broken piston rod from a small donkey engine piston. Thinking the piston was solid he put it on the fire and proceeded to heat it. When he thought he had it hot enough to pull off, he just got one hand on the rod when it exploded. Part of the piston went through a 2-in. plank and part of it struck the smith on the leg, cutting a great gash, and his face was filled with cinders. He was carried to the doctor on a stretcher and was laid up for several weeks.

Be sure there is an air hole, boys, before heating a piston. Chas. Burns.

AN INTERESTING OLD ENGINE

THERE is running today in the factory of Wethrill Bros., Philadelphia, an engine which has long survived the generation of men who built and started it. It was built by J. T. Sutton & Co. in Kensington, Philadelphia, about the year 1817, according to best authority, and was probably remodeled by the same firm some 30 yr. later, as a brass plate upon it bears the date 1847.

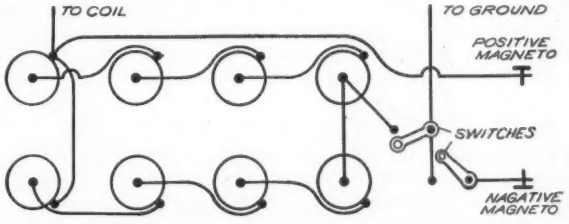
A few years ago, the requirements of the firm having increased very much, the question arose as to whether this old landmark had best be replaced by a modern engine. The subject was taken up by H. B. Underwood & Co. and it was decided to overhaul it. Nobody could remember when the bearings had been renewed. It is of the walking beam type, with a vertical cylinder 15½ by 48 in. and was built for about 40 lb. steam pressure and developed about 70 hp. After remodeling, it was speeded up and with the equipment of new boilers carrying 100 lb. steam, an indicator test showed that it is now developing 120 hp.

The walking beam is probably 18 ft. long, rested upon a center bearing, which is on the top end of a huge old fluted column about 15 ft. high and being hollow, formerly served for a feed-water heater. The exhaust steam entered it from one side and the feed water from the other. The old pump is still in use, being operated by a plunger rod attached directly to the beam about 18 in. from the fulcrum. This arrangement has long since been abandoned and a new Cochran heater installed, which makes an interesting combination, the oldest and the newest engine room apparatus operating together. Edw. T. Binns.

BATTERY AND MAGNETO ON A JUMP-SPARK SYSTEM

IN operating the ignition circuit of a gas engine I at one time had occasion to use a magneto on a jump-spark coil. As I did not have a magneto specially built for this system I asked a number of men supposed to know something about it and every one of them had an idea and theory of his own. At last I found a friend who told me how to wire a battery and connect it with the magneto so that the magneto could be used.

The idea was to connect the magneto to the battery instead of to the coil, and the electric current



ARRANGEMENT OF BATTERY FOR JUMP-SPARK IGNITION

when it passes through the battery is transformed into the kind of current that is required to work in a jump-spark system. When the engine is started the battery is not switched off but the magneto is switched on to it. Herewith is a connection diagram showing the arrangement of the magneto and battery. Any suggestion as to an improvement of connections or as to the working of this plan I shall be glad to know about. B. Ulrich

SMALL SUCTION PIPE

ABOUT a year ago I took charge of the steam end of a manufacturing plant where I am now employed. The former engineer in charge said he had about 35 yr. experience, against my 12 or 13.

Well, they purchased a new duplex National boiler feed pump, 2½-in. suction handling water from the hot well at about 175 to 185 deg. For some reason this pump would not handle hot water, I don't know the reason as I never saw the pump working. They exchanged the duplex, however, for a simplex National which has a 3-in. suction, both pumps having 2-in. discharge to boiler.

The engineer and the yard foreman doing the work, simply connected the simplex pump in the place formerly occupied by the duplex, and their troubles began again; the pump would run a little while then stop. Finally an S. C. regulator and pump governor was installed and then matters became worse; the pump would fill the boiler then the governor would check the pump down, then it would stop. No man around the factory could explain the cause. They ran this way for about a year, when they discharged the engineer, not from result of pump alone but other reasons besides.

Well, when I took hold of the job the superintendent asked me a few questions relative to pumps. I told him what little I knew about pumps and thought perhaps I could remedy the evil after a while.

The fireman said the pump was no good. I tried to change his mind by saying the National is a good pump. There were 3 other pumps in the pump house, all running fine, causing no trouble, they were all Marsh pumps. I watched the National run a few days before I located the trouble, then I called the fireman and asked him if he had any idea why the pump would not run. He said it is no good; I said the pump don't get water enough as it has only 2½-in. suction where it should have a 3-in. But he would not believe that when the pump discharged into a 2-in. pipe. The yard foreman had the same idea.

Well, when I went to the superintendent and explained to him he agreed with me, but I had to run the pump as it was nearly 2 months before we could make the change as we could not shut down then.

The foreman who helped put in the pump and pipe raised a great objection, said it was all foolishness to change it as it would do no good and would be a big job, but the superintendent put the work in my charge, so in July the fireman, 2 yardmen and myself went at it. It took us 5 days to make the change from 2½-in. pipe to 3-in. Did it work? Well, it has never missed a stroke, runs as nice as a top and the foreman and fireman are surprised. L. H. Sisson.

THOSE QUEER CARDS

ON page 510 of the Aug. Practical Engineer, W. D. presents 2 cards taken from the high-pressure cylinder of a cross-compound Corliss engine.

It would seem to me that the second card, the unusual one, was caused by a sudden release of load. The cutoff occurs late in the stroke on the crank end

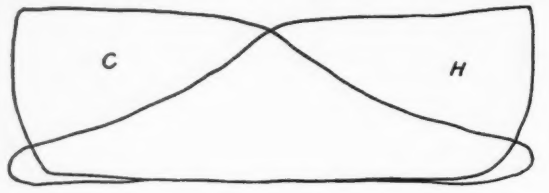


FIG. 1

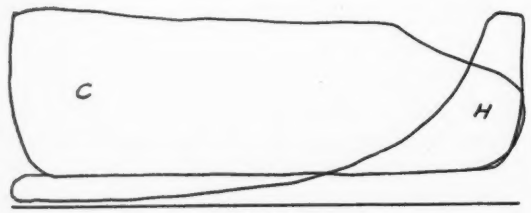


FIG. 2

CARDS REPRINTED FROM PAGE 510 OF THE AUGUST ISSUE

and early on the head end, showing a change from heavy overload to light load or no load within 1 revolution; or possibly from light load to heavy overload.

We have taken similar cards from a cross-compound Buckeye engine in the power plant of The Pennsylvania & Lake Erie Dock Co. at Fairport Harbor, O. These engines have cylinders 24 and 42 by 36 in. running at 100 r.p.m.

We frequently get changes from 100 per cent overload to nothing within 1 revolution of the engine.

In the card shown, the cutoff coming very early in the stroke causes the expansion line to go below the back pressure line because of so little steam being admitted to the cylinder. C. D. Eldredge.

CONCERNING the indicator diagrams for discussion, page 510, it looks to me that an overload suddenly occurred just as the crank end diagram was being traced, and just as suddenly dropped off as the head end figure was taken. This is possible, even though it may not have been the cause of the difference in the diagrams under consideration.

If, as the correspondent states, the valves were correctly set at the time the diagrams were obtained, the most likely thing that could happen to produce such a change in the size of the diagrams, is a sudden change in load, both in coming on and in going off. This could occur during one revolution of the crank.

It would be interesting to learn what kind of diagrams were obtained after those shown in Fig. 2. Were they not like those in Fig. 1? It is fair to assume that you did not put the indicator away immediately after getting the card shown in Fig. 2. Let us hear further from you about it. Charles J. Mason.

BADLY TWISTED

SOME time ago I read an article in a certain technical journal devoted to engineering which struck me at the time as stating the case exactly. The article in question told how the public gained such absurd and erroneous impressions of steam engineering, as we all know that the average person has on such subjects, received principally from reading fiction magazines.

The article referred to was brought forcibly to mind recently while reading a current story magazine containing a sea story in which a steam yacht was described. The description started by stating that it was a "turbine engined craft" and a little farther on gave an account of an incident which happened in the engine room and read about as follows:

A crash was heard in the engine room. The engineer hurried up and reported, "Crank pin of the forward engine carried away and the connecting rod went with it." A cloud of steam was pouring from the engine room. The chief reported the matter was not very serious and stated that he had "disconnected the forward cylinder and started the engines."

Now just think of it, all those crank pins, connecting rods, and "forward cylinders" on a turbine.

It would be only natural to suppose that a man who had his data so badly mixed in mechanical matters could scarcely tell the difference between a turbine and a surface condenser if he were to see both at the same time. Such persons do at times make truly laughable mistakes. Le Roy Scott.

EFFECTS OF STATE LICENSE

THERE has been much said and written relative to the Massachusetts license law. Although it is far from perfect in the opinion of the writer it certainly has been one of the best educators of the up to date steam engineer.

The young man who enters the steam engineering business in this state today, knows that to advance in the profession he must have the required knowledge and ability, that he must go before men who know, and prove his ability before he can secure the license for which he applies.

In the beginning the average man doubts his own ability, he therefore starts reading works covering engineering, studying mathematics and mechanics; he becomes thoroughly interested and one thing leads on to another; he learns from the writings of others

that which he could not possibly learn in a lifetime of personal experiences.

He receives his third class, then his second class license, and finally, after 6 or 8 yr. of hard work and study, his first class license.

By that time study has become second nature to him and it is easy to keep up to date.

There are hundreds of men in this state who are expert operating engineers, who, but for the license law, would still be nothing but coal-shovel and oil-can artists. C. H. Bastow.

FIXING THE FILTER

I HAD a lot of trouble with oil running all over the floor when I was busy, as our plant is small and the oil runs from the filter into a pail and is then put back into the tank near the engine. I stood this for a while trying to remember to empty that oil, but every little while I would get busy doing something else and forget until the flood came, and so I sat down and thought out an automatic arrangement which so far has worked fine and I think it may come handy to some other engineer.

Taking a magnet coil from a large sized electric bell I soldered it to the tank 4 in. away from the faucet and in line with the faucet handle, Fig. 1, also soldered a piece of ¼-in. round iron 2¼ in. long about 3 in. from the coil and in line with the bottom of the coil; I then put a spool on this rod.

In the end of the faucet handle I bored a hole so as to tie in a string. This string ran to one end of a piece of flat iron which acted as a magnet armature, and from the other end of the iron the string continued to a weight immediately under the spool. I left the string long enough so that the iron would come over

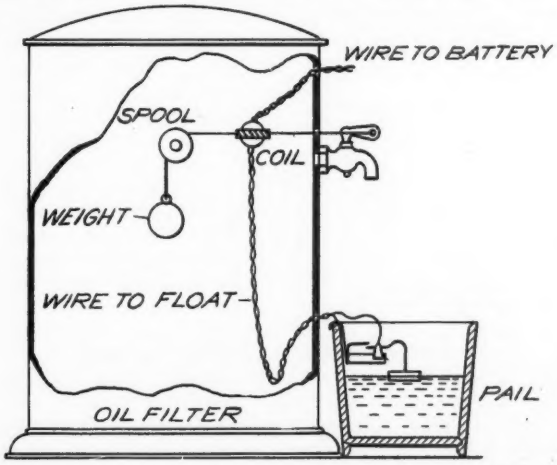


FIG. 1. PARTS OF FLOAT DEVICE ON THE FILTER TANK

the center of the coil when the faucet was open, and the weight on the end of the string was made heavy enough to close the faucet, the amount required being found by experiment. Of course, a light spring could be attached to the end of the string and fastened to the rod in place of the weight.

A float was then arranged to put in the pail which receives the oil, this float being made as shown in Fig. 2. A piece of wood 2 in. by 1 in. has ears fastened on either side to carry a wire nail, these ears acting as bearings and the nail as an axle. To the nail is soldered a piece of copper strip ¼ in. wide and about 5 in. long, bent L shaped, and to the lower end a cork float is attached, while the horizontal end rests against a contact which is screwed to the end of the block. The other end of this contact is bent hook shaped to hang on the edge of the pail, this hook and contact being also made of ¼-in. copper strip. Back of the filter a battery is placed and is connected to the magnet coil and to the float as indicated, so that as long as the cork float is down, current will flow from the battery through the magnet coil and attract the iron strip. When the oil level is below the float, the contact will remain closed and the iron armature will be held against the core of the magnet. When oil strikes the cork it lifts it, separating

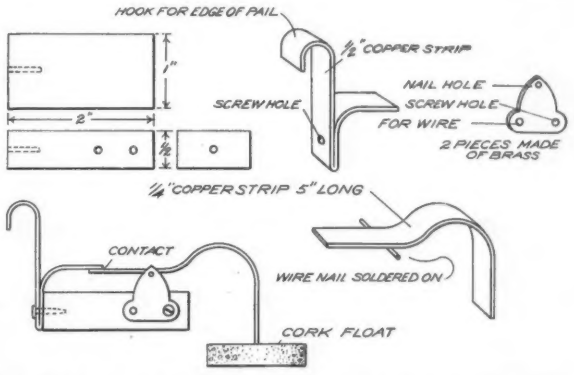


FIG. 2. DETAILS OF MAGNET ARMATURE, FLOAT AND HOOK

the contacts, and current stops. The weight then pulls the string over the spool and closes the faucet.

When you remove the pail, the float should, of course, be placed in such position that the contact will remain broken to prevent running down the battery. The cork should be placed well below the body piece of the float so that the electrical connections and contacts will not get into the oil.

D. W. Etchings.

LOW-PRESSURE CUT-OFF AND RECEIVER PRESSURE

WITH regard to the answer made to question 4, page 511, I would say that I do not quite agree with all that has been said. While it is true that the low pressure cylinder never puts steam back into the receiver, that fact in itself is not sufficient proof for the statement that it cannot affect the raising of the receiver pressure. The receiver pressure of either a cross-compound or a tandem-compound Corliss engine may be either raised or lowered by adjustment of the low-pressure cut-off mechanism. An early cut-off in the low-pressure cylinder—the cut-off in the high-pressure remaining the same—would cause the receiver pressure to increase; but if the low-pressure cut-off was made later, the receiver pressure would drop.

You can obtain almost anything in the way of pressure in the receiver, from zero (gage pressure) to the terminal pressure in the high-pressure cylinder, according to the relation which exists between the volume of the high-pressure cylinder and that of the receiver, and also to the adjustments of both high and low-pressure cut-offs. The answer to the question would have the reader think that in order to raise the receiver pressure he must make the necessary changes and adjustments on or at the high-pressure cylinder and valve gear, and that he cannot expect to make the change by anything he can do at the low-pressure cylinder. Chas. J. Mason.

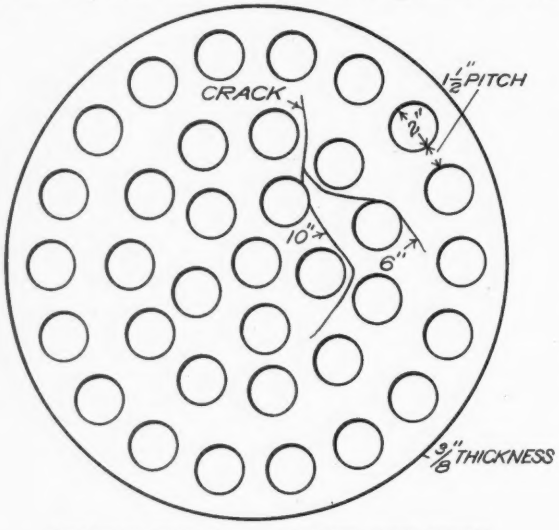
Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

Thump in an Engine

WE have a marine type engine in which the piston comes over the steam ports about 1.5 in. Every time it comes up on top the steam throws the piston against the farther side with a thud. To make matters worse, this is a solid piston, with no way of adjustment to center the piston. If we thrust the engine forward to put it out of line it will help, but I thought if there was some way to set the valve, which is of piston type, so it would make the admission late, with the least possible lead, it might help.

The engine has link motion, is fore and aft compound, 14 by 28 by 18 in., running 140 revolutions with steam 150 lb. pressure. Stuffing boxes are shallow, so that they give no help in steadying the piston. If we had a piston with an adjustable ring and a tail rod it would probably stop the trouble, but I would rather try changing the valve setting first. I should be glad of any advice from Practical Engineer readers as to what is best to do. W. M. J.



LOCATION OF CRACK IN BOILER TUBE SHEET

Transmission Line Loss

IN our plant is a dynamo of 500 amperes at 250 volts direct current, rated at 100 kilowatts. We furnish power to 4 motors at a distance of 1 mile over No. 0000 B. and S. wire, the load on these machines varies from zero to 300 amperes. We are having quite a bit of trouble with the power. I figured out that for every 50 amperes load there is a drop of 12.5 volts. Is this correct or not, and if it is, can any one suggest a practical way to remedy our trouble, or will it be better to move the machines if there is no expense but the moving, i. e., no steam power to figure on?

H. A. W.

Patching a Boiler Head

IN OUR plant is a vertical boiler 3 ft. in diameter which carries 50 lb. gage pressure. There is a crack in the upper tube sheet as shown in the figure herewith, the thickness of the sheet being ⅜ in. Can any reader suggest a method of patching this or is a new tube sheet necessary? E. P.

Heating By Exhaust

I AM running an old slide valve engine of 300 hp.; I have 4 boilers and use sawdust and planer shavings for fuel. The load is 6 planers, 1 large bandsaw and cutoff saw. Behind each planer the fan is a double 50-in. running about 1400 r.p.m. Three dry kilns 30 by 90 in. have a pipe from boilers 135 ft. to where it enters the kiln. Three boilers will handle the load easily without the kilns on, but as soon as the kiln valve is open it begins to drag.

I see in the editorial of the August number, 1909, quite an argument about exhaust steam and live steam for heating a building. Now, why couldn't the exhaust steam be used in the kilns? They are the common, old-fashioned kind, 1-in. pipes from end to end; 2 layers as thick as they can be put together. The boilers are 115 hp. each; the kiln pipe is 3 in., the exhaust pipe 8 in. Would it be possible to connect up in any way to the kiln and use the exhaust steam in the day time and live steam at night? We now fire 2 boilers at night and burn about 7 cords of slab wood. One man does the trick and has to handle the wood twice, making 14 cords in the night. Should it take that much wood and steam to keep the kilns at 180 deg.? Nothing else is on at night. If this can be done it will save breaking in a new fireman about every 3 weeks. B. C.

Pipe Expansion; Loss of Vacuum

WHAT is the best method of figuring the expansion of a new steam main?

2. In what different ways may vacuum be lost with a surface condenser having dry vacuum pump, and wet vacuum pump, the latter controlled by the flow to the hot well condenser? What is the reason for losing vacuum with an increase from, say, 26 in. to 28. in.?

Stack Dimensions

HOW high would you build a smokestack for a boiler plant having 2 6 by 18 ft. horizontal tubular boilers, with 80 4-in. tubes, the stack being placed directly on top of the boiler setting? What draft, in inches of water, should you have at the base of the stack, at the front end of the tubes, and in the furnace?

2. Why do the sheets of a horizontal boiler sag?

A. A boiler 6 by 18 ft. with 80 4-in. tubes will be practically 150 hp. As to the draft needed, this will depend on the kind of coal to be used. For a free-burning bituminous, burning 15 lb. of coal per square foot per

hour, a draft through the boiler setting would be 0.11 in. of water. Draft at the base of the stack is usually run at about ¼-in. and the draft through the furnace and ashpit would be about 0.07. This would give as the drafts at the different points which you mention, ¼-in. at the base of the stack, which would give the same as that at the front end of the tubes, 0.36 in the furnace and 0.43 in the ashpit.

To take care of the 150 hp. would require a stack 35 in. in diameter, or for even figures, say 36 in. in diameter and 70 ft. high. For good measure, make this 80 ft., so as to have reserve capacity; or if the boiler is to be forced to the utmost possible limit it would develop probably 250 hp. and would then need a stack 42 in. in diameter by 100 ft. high.

2. The reason for bagging in the sheets of a horizontal boiler is overheating of the sheets. Usually this comes from the accumulation of scale or sediment on the bottom sheets, which prevents the carrying away of heat by the water inside. The plate, therefore, overheats until it becomes weak and the pressure inside the boiler forces it down.

Pipe Covering; Indicator Diagram; Pump Problem

A. L. J. asks for a cheap, serviceable pipe covering to go inside the box shown in the sketch. If he is in a locality where he can obtain cotton-seed hulls and loam or clay, I think he will find about what he wants, by mixing them together in proportions of 1 to 1, with enough water to make a mortar-like consistency, and pack it in the box around the pipe.

This, when dry, is a good non-conductor of heat, and is one of the cheapest things he could use; it also makes a fine covering for boilers, is easy to put on and usually stays; when used this way add 1 per cent salt.

I am of the opinion that the peculiar jog in the expansion line of W. E. S.'s indicator diagram was caused by too much lap on the steam valve which caused it to pass the post on closing, thus giving a double admission.

The pumping problem submitted is rather interesting. F. A. R. does not state the height of the tank above the pump, and this would have a direct bearing on whether or not the pump could empty the tank.

Assuming the pump to be a perfect one and the bottom of the tank about 4 ft. from the pump cylinders, as it appears to be by proportion in the sketch, I believe the pump could empty it.

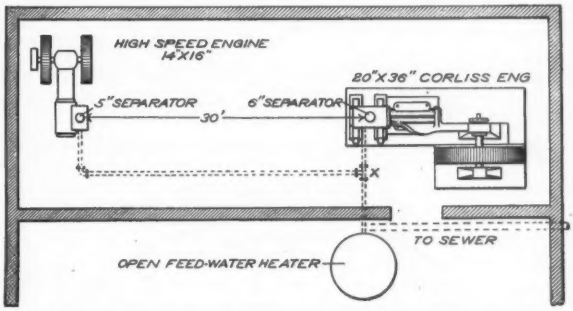
If, however, the tank was placed close to the pump I don't think it could be emptied, as the difference in atmospheric pressure between the tank and pump would be the only force acting to move the water, after atmospheric pressure was removed from within the tank. I would like to hear opinions from other readers.—W. F. Cox.

The Use of Steam Traps

I HAVE 2 engines located as shown in the sketch herewith, each provided with a separator. I wish to drain the water from these separators by a trip to the open feed water heater. Should I place one trap at the point marked X to drain both separators, or a trap near each engine? The present location of drain pipes is indicated on the illustration. The open feed-water heater is about 12 ft. from the point marked X. Would a non-return trap discharge into the top of the heater about 12 ft. above X? Our boiler pressure is 120 lb. How large a trap should I use, the steam line to the Corliss engine being 60 ft. long, and to the high speed engine, 100 ft.?

A. Theoretically you should place a trap at each separator; but in fact, it would hardly be advisable, as the cost of 2 traps would be more than the saving made would pay for. Your boiler pressure will easily raise the condensation to the heater but you must have a return trap to do this. As to the style and size of trap, the return trap is almost invariably a float, and this, if set a little above the horizontal run of the drain pipe, will make a water seal between the trap and the vertical riser to the separator. In the float trap the water never falls below a certain point and if the trap is set a little above the horizontal run, the water will back up in the drain pipes and act as a perfect seal for the steam so that none will escape through the trap.

The trap should be of the size to give as large opening as the drain from the separators and if one trap is used



PLAN OF PLANT SHOWING LOCATION OF SEPARATORS

for the 2 separators its opening should be as large as the combined area of the 2 separated drips. Probably these drips will be ¾ or 1 in. In the former case the trap would be 0.88 sq. in. area and as this is a little less than the internal area of a 1-in. pipe, the trap would have 1-in. connections. If the drains are 1 in., the trap should have 1.5-in. connections.

Practical Questions From a State Examination

IF THE water in your boiler became so low that you could not find it, state in full what you would do until you had your plant in full operation.

(2) How many square feet of heating surface in a boiler 15 ft. long 48 in. in diameter with 30 4-in. tubes using ½ of the shell and no heads?

(3) What height will a pump lift water in practice and in theory?

(4) What causes a pump to lift water?

(5) State a simple remedy for cleaning the scale from an injector.

(6) What causes an injector to force water in a boiler at the same pressure that the steam was taken?

(7) Draw or describe an open feed water heater.

(8) Draw or describe a closed heater.

(9) How would you regulate your feed water with a steam-driven pump? With direct connected pump?

(10) For a column of water 85 ft. high, what is the pressure at the bottom?

(11) How would you set the valves of a simplex pump? Explain in full.

(12) In feeding a stand pipe, where would you place the inlet and why?

(13) A pump has a steam cylinder 6 in. in diameter 6-in. stroke, 3½-in. water cylinder, 80 lb. steam. What pressure will it pump?

(14) What is a vacuum and how is it measured?

(15) What is the difference between a condensing and a non-condensing engine?

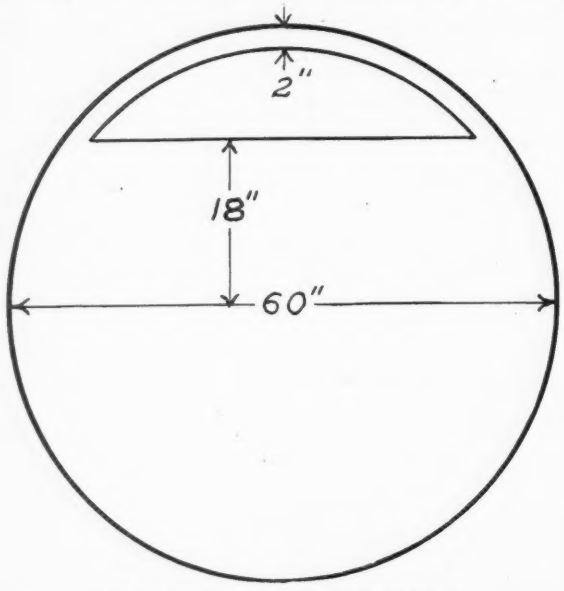
Answers to these questions are invited. The best set will be paid for and published in November issue. Answers should reach us by October 1st.—Editors.

ANSWERS TO QUESTIONS IN JUNE ISSUE, PAGE 349

By J. M. Row

TO FIND the steam pressure that can be supported by 10 stays, each good for 6000 lb., on the area as shown in the illustration, it is first necessary to find the area of the segment to be supported. This may be found by the following rule: Divide the diameter of the circle in inches by the height of the segment in inches and from this subtract the constant 0.608; extract the square root of the remainder, divide this square root by 3 and multiply by 4 times the square of the height of the segment.*

Performing the operation indicated we have $\frac{56}{10}$ 0.608=4.992. The square root of this is 2.233, and dividing this by 3 and multiplying by 4×100, gives 297.9 sq. in. The diameter of the circle to be stayed is



BOILER HEAD AREA TO BE SUPPORTED

found by subtracting 4 from the diameter of the boiler, 60. The height of the segment is found by subtracting 18+2=20 from the radius 30, giving 10. 10 stays, each good for 6000 lb., gives a total of 60,000 lb. to be distributed over this area, and dividing 60,000 by 297.9, gives 201 lb. as the safe pressure to be carried.

2. For a compound engine the number of expansions may be determined by dividing the square of the diameter of the low-pressure cylinder by the product of the cutoff and square of the diameter of the high-pressure cylinder. In the case of the problem the low-pressure cylinder is 20 in., high-pressure 10 in., and cutoff ½ this becomes $\frac{20\times20}{0.5\times10\times10}$ which works out to 8 expansions.

3. One of the greatest advantages gained from compounding engines, especially with a late cutoff, is in the diminished temperature variation throughout the stroke. In order to realize the greatest advantage from this source it is essential that the temperature variation be equal in the 2 cylinders.

Assume the initial pressure to be 125 absolute and the engine running condensing, in which case the back pressure would be about 4 lb. From the steam tables we find the temperature of steam at 125 lb. pressure to be 344.2 deg. and at 4 lb. it is 153.1 deg. F. 191.1 deg. is the total change in temperature from admission to exhaust. Half of this, or 95.5, will be the change in each cylinder. The temperature in the high-pressure cylinder will range, then, from 344.2 to 248.7, while the temperature in the low-pressure cylinder will range from 248.7 to 153.1.

The pressure corresponding to 248.7 deg., taken from the steam tables is about 29 lb., hence 29 lb. is the pressure at which the steam will be admitted to the low-pressure cylinder. It only remains, now, to proportion the cylinders so as to get equal work out of them.

This can best be done, without mathematics, by constructing the theoretical diagram for each cylinder and measuring the mean effective pressure of each one. We find the m.e.p. for the high-pressure cylinder to be 85.8 and for the low-pressure it is 22.6. To get equal work in the 2 cylinders we must have the following proportion, when X equals the diameter of the low-pressure cylinder $X^2:15^2::85.8:22.6$

and $X=\sqrt{\left(\frac{225\times85.8}{22.6}\right)}=29$ in. diam.

4. A hundred horsepower boiler would evaporate 3000 lb. of water an hour, from a temperature of 100 deg. F. to steam at 70 lb. gage. Allowing 50 per cent for overload, then 10 per cent for slip in the pump and dividing by 62.4 we find the displacement of the piston of the pump must be 80 cu. ft. an hour nearly.

It is next necessary to decide upon the ratio between the length of stroke and the diameter of the piston. The ratio 3 to 2 is frequently used and we will accept it. To obtain the best service from a pump it is best not to exceed 60 double strokes a minute.

If the displacement per hour is 80 cu. ft. and we run 60 double strokes, or 120 single strokes a minute, the displacement per stroke will be 192 cu. in. For a duplex pump it will be one-half this amount or 91 cu. in.

The area of the cylinder will be 0.7854 times the diameter squared, and this times the length of the stroke will give the cubic inches displacement per stroke, but we have decided to make the stroke to the diameter as 3 is to 2, or the stroke will be 1.5 times the diameter. If we, therefore, multiply the area by 1.5 times the value of the diameter, it will give us the displacement. If we let D stand for the diameter we then have, area= $0.7854\ D^2$ and this multiplied by 1.5 D gives $1.176\ D^3$, which is equal to 91 cu. in. The cube of the diameter will, therefore, equal 91÷1.176, which is 77.2, and the cube root of this will be 4.25 in., then the stroke will be 1.5 times this or 6⅜ in.

In order to force this water into the boiler it is necessary that the steam piston be larger than the water piston. About 25 per cent greater area will be sufficient. That will make the diameter of the steam piston 4¾ in. The size of the pump would be 4¾ by 4¼ by 6⅜ in.

5. The data given is not sufficient to make a definite solution of the problem, but the method to be employed is as follows:

The diameter of the stays is first decided upon. They are usually from ¾ to 1 in. To find the number of stays: Multiply the area to be supported by stays, by the gage pressure. Then multiply the cross sectional

* In brief form this becomes $A=\frac{4h^2}{3}\sqrt{\left(\frac{D}{h}-0.608\right)}$ where D is the diameter of the circle to be stayed and h is the height of the segment to be stayed, both in inches.

area of the stay by its allowable stress per unit area, and divide the first product by the second. The quotient should then be divided by 5 for a factor of safety.

6. With cutoff at 1/3 stroke in the high-pressure cylinder and neglecting clearance, there will be 3 expansions in the high pressure cylinder. If the cutoff is also 1/3 for the low-pressure, since the volumes are in the same ratio as the squares of the diameters, the volume at low-pressure cutoff will be 4 times that of the high-pressure cutoff, hence the initial pressure in the low-pressure cylinder will be ¼ the boiler pressure. All calculations must be made on absolute pressures. Assuming that the 145 lb. given in the problem is absolute, initial pressure in the low-pressure cylinder will be ¼ of that or 36 lb. Mean effective pressure may be found by constructing the ideal indicator cards or by the following rule: To the hyperbolic logarithm of the ratio of expansion add 1. Multiply by the initial pressure absolute and divide by the ratio of expansion and from the quotient subtract the back pressure absolute. In the present example the hyperbolic logarithm of 3 is 1.0986. Adding 1 gives 2.0986, and this multiplied by $\frac{145}{3}$ and 36 subtracted from the quotient gives 75 lb. as the mean effective pressure in the high-pressure cylinder. To correct for condensation, compression and other losses, multiply by the factor 0.9, which gives 67.5 lb. as the probable mean effective pressure. In like manner, assuming a back pressure of 6 lb. absolute in the low-pressure cylinder, the mean effective pressure is found to be 19 lb.

At cutoff the cylinder has one-third of its volume filled with steam at a pressure of 145 lb. absolute. This represents 2.357 cu. ft. per stroke. Assuming the engine to make 100 r. p. m., or 200 strokes, it will consume 28,284 cu. ft. an hour. Referring to the steam tables we find the weight of a cubic foot of steam at a pressure of 145 lb. to be 0.3217. The total steam consumption an hour is then $28{,}284 \times 0.3217 = 9100$ lb.

To get the quantity of cooling water we subtract from the total heat in the exhaust steam the total heat in the steam leaving the condenser, also from the temperature of the cooling water leaving the condenser subtract its temperature when entering the condenser, divide the first remainder by the second.

By use of the steam tables we may find the total heat in one pound of steam at a pressure of 2 lb. (assuming the vacuum to be 26 in.) to be 1120.5 and the heat in the liquid to be 94.4, we will assume entering and leaving temperatures to equal 60 and 120 deg. F. respectively. Then we have $W = \frac{1120.5 - 94.4}{120 - 60} = 17.1$ lb. The total amount of cooling water will be $17.1 \times 9100 = 155{,}610$ lb. The size of the pump may be found the same as in problem 4.

The cooling surface is found by dividing the total steam to be condensed per hour, by 13; this gives 700 sq. ft.

7. To find the diameter of the crank shaft on the engine, divide the indicated horsepower by the revolutions per minute and extract the cube root. Multiply this by a factor depending upon the material and another factor depending upon the cutoff, these factors being as follows: For the material factor with iron shafts, use 3.85 and for steel use 3.5. For the cutoff factor at 0.2 use 2.625; at 0.4 use 2.125; at 0.6 use 1.835; at 0.8, use 1.698.

If we assume that the engine in question makes 100 r. p. m. and the cutoff is at 0.4 stroke, the horsepower being as given in the example, 300, we have $300 \div 100 = 3$. The material factor is 3.5 for a steel shaft and with cutoff at 0.4 the cutoff factor is 2.125. Multiplying together 3.5, 2.125 and $\sqrt[3]{3}$ we get 10.7 in. as the diameter of the crank shaft.

8. The best way to find the temperature of steam at a pressure of 175 lb. or any other pressure is by referring to a steam table. But it may be found from the following formula:

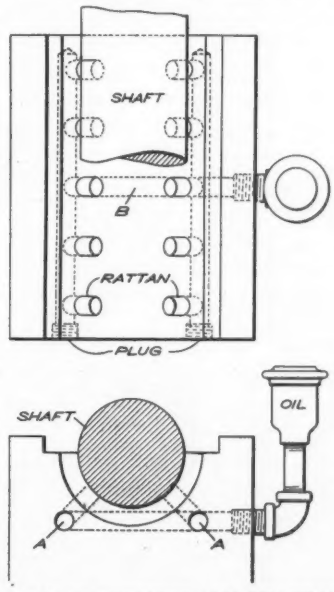
$$t = \frac{2938.16}{6.19935 - \log P}$$

in which t=temperature
P=pressure=175
Log. 175 =2.24304

From this formula we find t=377+. This corresponds very closely with the value found in the steam tables.

SUPPORT FOR SHAFT WHEN BABBITTING

AN EXCELLENT support for a shaft when babbitting, which may be used afterward for lubricating purposes, is made by inserting pieces of rattan in two rows of holes drilled in the casting as shown in the accompanying illustration. The holes should be about ¼ inch in diameter, and the rattan cut long enough to support the shaft in the proper position. Two holes A should also be drilled lengthwise of the bearing to connect the bottoms of the holes in which the rattan pieces are inserted. The ends of these holes A are plugged as shown. After the babbitting is finished, a hole B should be drilled across the bearing to connect the oil cup with the supply chan-



RATTAN SHAFT SUPPORTS AND OIL CHANNELS

nels A. When the shaft is in place and in motion, it draws the oil through the rattan pieces which wear evenly and which are always in contact with both the shaft and the oil in the supply channel below. This feeding action is due to capillary attraction combined with gravity. S. C. Smith.—Machinery.

LEATHER WASHERS smeared with soap will not leak gasoline.—Penberthy Engineer and Fireman.

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LIGHTING COSTS

Since light is one of the chief products of the modern power plant, any knowledge in regard to its production is of importance to engineers.

Looked at from the standpoint of the individual, proper lighting of rooms, particularly those where one's daily work is done, is of the greatest importance, for poor lighting means not only wasted energy from eye strain but damage to the eyes which will lessen his usefulness and enjoyment.

To the employer, good lighting is of importance for it increases the efficiency of workmen and decreases sickness, keeping the output larger in quantity and better in quality.

These are well recognized facts and apply to men working in all parts of the power plant as well as to others. Many times the plant itself, pump room, boiler room, even engine and generator room are the worst lighted parts of the whole factory; and it's largely the fault of those working there, for a little trouble in running circuits and arranging drop lights or wall sockets would remedy the whole matter. The materials are usually in stock and the extra current needed could not be discovered on the instruments.

Good lighting means not barely light enough to do the work, but light such that a room has a cheerful appearance and seeing is easy. It means also an arrangement of lights that gives good illumination where needed, but keeps the glare of the lamp itself out of the eye. And such lighting is worth all it costs even if the cost had to be high, but it need not be, and in fact the difference in cost between few lights and murkiness and lights to give a pleasant brilliance is a very small per cent of the cost of lighting a building.

S. E. Doane, chief engineer of the National Electric Lamp Association, in an article on the cost of light, has brought out clearly the factors on which this cost depends.

Cost of electrical service includes the cost of plant and of keeping it running, ready to deliver current. If the current be used for power, of course a part of the cost of service goes against the power but the extra capacity of generators, engines, boilers, auxiliary apparatus, wiring and lighting fixtures stands as the cost of service or readiness to serve.

And this cost will be increased but little by the addition of the few extra lamps needed to change gloom to effective light. In fact, the capacity in machinery and circuits is usually already provided, and only the taps and sockets are insufficient.

Cost of electrical energy and cost of lamp renewals are the other factors. Of the items making up the cost of electrical energy, labor will be no greater with a few lights more or less, nor will cost of oil, waste or packing be increased; only the coal bill is affected and the cost there will be well repaid by the added efficiency of workmen.

Mr. Doane finds that from 50 to 90 per cent of the cost of current is in delivering it after it is generated

by the dynamos, and this will not be lessened to any appreciable extent by saving a few amperes current.

Lamp renewals are found to be an insignificant part of the total cost, hence, addition of a few lights will have no appreciable effect in the expense of running the plant.

As figures for running a carbon filament lamp of 16 c. p. for 1000 hr. Mr. Doane gives $5 for service and current and 27 cents for renewals. In this case the lamp is figured to take 3.1 watts per candle power or 49.6 watts per lamp.

By the introduction of more efficient lamps such as the Mazda, the customer or lights capacity of the plant is increased so that not only is the cost of the energy used by the customer reduced, but the service cost of the system is divided among more customers and the service cost to each reduced.

Energy cost may be varied not only by changing the type of lamp, but by the voltage at which the lamps are burned. A high voltage gives low energy cost per candle power, but shortens the life of the lamp and increases renewal cost. At some point these will be so balanced as to give the lowest cost of operation.

By a comparative table it is shown that where the cost of electrical energy is more than 1 cent a kw.-hr. the tungsten lamp bought at list prices is cheaper to use than the carbon filament lamp supplied free and if carbon lamps must be paid for, the tungsten has the advantage down to a current cost of 0.2 cent per kw.-hr. Where energy costs above 6 cents per kw.-hr. the lamp should be burned at the highest allowable voltage, which is usually 2 volts above normal.

By attention to these matters of detail the lighting cost of a building or works may be kept at a minimum and coal cost reduced just as surely as by watching the effectiveness of engine and boiler operation.

EXAMINATION QUESTIONS

Why is it that examiners who are supposed to test an engineer's knowledge of engineering frequently test even more severely his patience and his power of guessing? A question on which a man's success in getting a chance to earn a living may depend is worthy of enough attention and care so that its meaning shall be clear without guess-work.

When questions are copied or written from memory there is a chance that the applicant has slipped; but in original lists as given to the applicant and sent in to us there are often questions which either cannot be answered from the data given or may be answered in a dozen ways, according to what the person answering thinks that the questions mean.

In a recent list as published (and we realize that we are to blame for letting them appear in such obscure form), was a question as to "method of bracing" the furnace in a return tubular boiler.

What is a candidate to understand from the wording of this question? What does the examiner have in mind? As the furnace of a return-tubular boiler (in stationary practice) is simply a space enclosed by brick walls at the sides and rear, the boiler itself at the top, and the grate at the bottom, there is really nothing to brace. Perhaps the person asking the question means, bracing the walls of the furnace, for that seems to be the only way in which the question is to be understood, and if this is true, why did he not ask the question that way? There is almost as much skill and knowledge required in properly wording a question, as there is in correctly answering the question.

In another question the word "effected" is improperly used. Evidently it was intended that "affected" should have been used instead. If the question had read "what is the effect" of low water in a boiler of such and such type, and what parts would be affected first, there could be no misunderstanding on the part of the person being examined.

This may seem to be of no importance for the question might be understood whether the word affected or effected be employed. But care should be taken to use the proper word to convey what is meant to be carried in the sentence, and thus make clear to the reader (or to the person being questioned, in the case of a verbal examination) exactly what is required. In short, a question that is so worded as to cause confusion in the mind of a candidate for examination, is unfair, and perhaps will work an injury to a really deserving man.

If an examiner, after preparing a list of questions, will try to answer it as it is written—not as he means it to be understood—he can quickly tell whether or not the questions are clear and in proper form. Then there will be a real test of an engineer's knowledge, not of the nearness of his relation to a Yankee.

And when an applicant is confronted with a question whose meaning is not plain or which is not complete, if he will use his common sense to see what the examiner wants to know and will supply needed data to work out a problem, he will show his fitness to meet emergencies such as are continually arising in a plant, and also prove that he knows the subject well enough to answer the question as if all needed figures had been given

---

HUNTINGTON, W. VA. has now an engineers' license ordinance, and the first examinations were recently held under it. The rules of the board are that all applicants making 80 per cent will be given first class certificates; those making 60 per cent second class and those making only 40 per cent will be given special tickets allowing them to operate plants of not over 25 hp. Meetings of the board are being held 2 and 3 nights a week to examine applicants as rapidly as possible. When all now on the list have been examined meetings will be held regularly on the second Monday of each "week" (so the report states, and that's a rapid board to get 2 Mondays in each week).

FROM DENVER comes the report that the big plant at Shoshone Falls and the new power house of the Central Colorado Power Co. at Boulder have been sold to the Denver Gas & Electric Co.

Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

CLAFLIN TUBE CLEANING APPARATUS

A STEAM tube cleaner that involves many new and valuable features and known as the Claflin is meeting with considerable recognition in the United States, Canada and Mexico.

The practical construction of this appliance is illustrated by the accompanying cuts, and among the points of greatest interest will be noted the following:

Figure 1 shows the cleaner in its complete form ready for use. The dark shaded portions represent the parts of the cleaner as regularly furnished; the curved dotted lines merely represent a suitable length of steam hose attached and the dotted handle shows that it can be transposed from a horizontal to a 45-deg. angle connection, if desired, thus permitting the operator to reach much higher tubes without the use of a platform. The construction is entirely of metal, insuring strength and durability. The handle is tubular, which makes it light, yet strong.

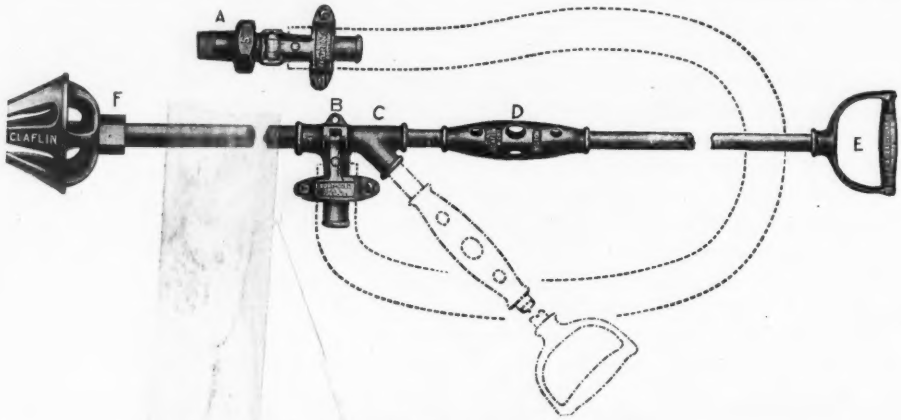


FIG. 1. CLAFLIN CLEANER READY FOR USE

The power of a steam tube cleaner (everything else being equal) depends upon the construction of the head. In this respect, the manufacturers of the Claflin cleaner claim their greatest stronghold, they being designers of the skeleton form of head, a sectional view of which is shown in operation in Fig. 2.

Steam enters the head through a divergent tapered nozzle (as used in steam turbines, injectors, etc.), and the nozzle is so proportioned to the steam supply and to the size of tubes to be cleaned, that it compels rapid longitudinal expansion of the steam in the direction of motion—through the tubes. At the same time, this steam imparts a terrific velocity to the great volume of air which it continually draws through the openings of the skeleton head.

The socket-like contact of the conical shaped skeleton head against the end of tubes insures centralizing the swiftly moving steam and air currents. The net result of this has a twofold effect; it balances the atmospheric pressure at both ends of tubes, because the influx of so much air destroys the vacuum that

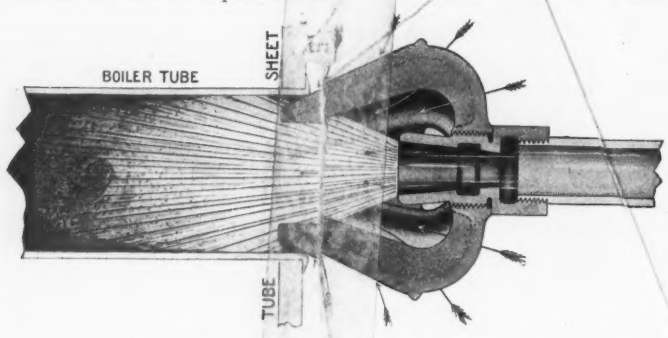


FIG. 2. SKELETON HEAD IN OPERATION

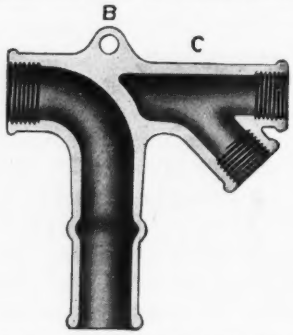


FIG. 4. SURE-HOLD STEAM HOSE COUPLING AND HANDLE FITTING

is naturally created as a sort of by-product behind the discharge of steam.

Figures 3 and 4 show the Sure-Hold steam hose fittings that are furnished for both ends of hose with each tube cleaner. The method of holding the hose securely can be seen by reference to letter A Fig. 3, which represents a circumferential enlargement, forming an outwardly projecting convex rib, the purpose of which is to bulge that part of the hose immediately encircling the rib.

B represents a concave recess formed on the inner surface of each clamp. When the clamps are brought together by means of bolts, these recesses not only surround the hose, but straddle the bulge created by the rib, thus producing an absolutely sure hold, hence the name Sure-Hold.

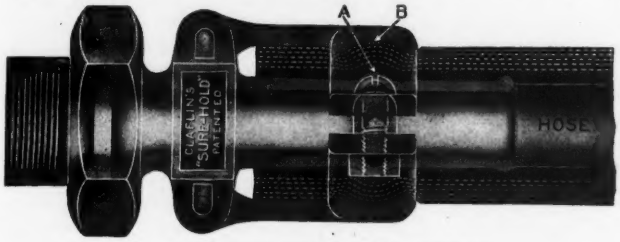


FIG. 3. SURE-HOLD STEAM HOSE FITTING

It is claimed that it is absolutely impossible to blow the hose off one of these fittings, if properly attached, which is a very simple matter; therefore, any hose that can be attached to them will burst rather than blow off. It will also be seen by reference to the cuts that the form of these hose fittings is such that the hose cannot be injured by their use.

Referring to Fig. 4, B shows an eye cast on the back of the special handle hose fitting, by which the complete cleaner and hose can be suspended when not in use, also affording means, if desired, for counterbalancing them when in use, through the mediumship of a suitable weight, cord and pulleys secured overhead.

Figure 5 shows a sectional view of the Telescope balanced steam valve, and Fig. 6 its application to the Claflin cleaner.

By reference to the index letters of Fig. 5, it will be seen that A is a cylinder provided with a packing chamber B and differential shoulder C, valve seat D, discharge bonnet E—containing outlet ports F F F, and all adapted to practically enclose the sliding valve plunger G G, which is provided with a fixed differential sleeve H, 4 steam ports I I I I, valve disk J and valve-closing lip K; L is a pipe tee fitted with plug M, which can be removed for introduction of lubricants.

The spiral spring holds the valve yieldingly against its seat and normally has ample tension to overcome the friction of the packing holding the valve closed thus, also preventing possible injury thereto when not in use.

Its operation is as follows:

Steam is admitted from boiler through supply valve and hose to the sliding valve plunger G G, where owing to the opposing effect of pressure on the acting areas of differential shoulder C and sleeve H, the valve J is held closed.

Steam pressure instantly balances and remains

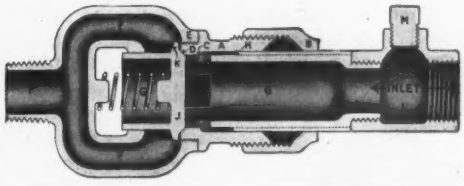


FIG. 5. TELESCOPE BALANCED STEAM VALVE

confined at steam ports I I I I, within a few inches of the end of the tube.

A slight push on the tube cleaner handle is all that is necessary, through the telescoping effect, to lift the evenly balanced valve J wide open, allowing escape through steam ports I I I I, outlet ports, F F F, and thence through nozzle of the cleaner head and into tubes, thus producing a quick and powerful blow at full boiler pressure.

The flow of steam continues as long as the cleaner head is held against the end of tube, but upon relaxing the thrust on handle, as in moving the cleaner head from one tube to another, the valve J automatically closes, because the open position of valve is such that interior surfaces of bonnet E and outlet ports F F F are exposed to steam pressure, in opposition to valve closing lip K, which tends to force them apart, or into closed position of valve.

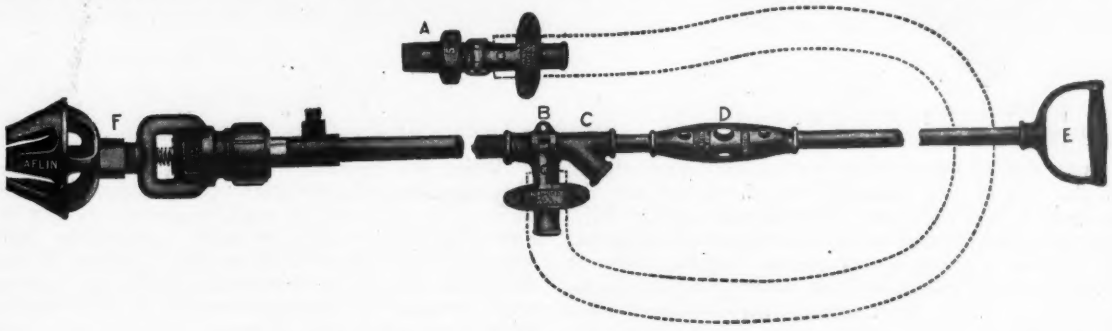


FIG. 6. APPLICATION OF THE TELESCOPE VALVE TO CLAFLIN CLEANER

The addition of the Telescope balanced valve makes the Claflin an automatic steam tube cleaner. The valve is made entirely independent of the cleaner and can be furnished complete with cleaner, or added afterward. In either event it is connected closely behind the head and does not interfere with the induction of air.

This apparatus together with other styles of tube cleaners, hose fittings and special braided steam hose, known as the Vulcan, is manufactured by Chas. A. Claflin & Co., 58 High Street, Boston, Mass.

JEFFERSON SWING UNION

COMBINATIONS made possible by using the various parts of the Jefferson Swing Union, made by the Jefferson Union Co., Lexington, Mass., in connection with the regular Jefferson parts, make it applicable to so many kinds of odd connections that it may almost be considered as a universal union. The accompanying cuts show the union in 5 different positions, and also a section showing the spherically ground seat which will make a tight joint regardless of the angle of connection.

The regular Jefferson Swing Union consists of 2 45-deg. elbow parts, but a 90-deg. elbow or a regular straight Jefferson part, or a male and female part, may be used in combination with one of the 45-deg. elbow parts. It is made of malleable iron, with a spherically ground iron-to-iron seat, or at slightly additional cost a regular Jefferson brass-to-iron seat.

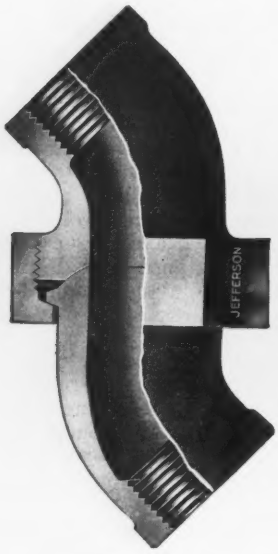


FIG. 1.
SECTION OF JEFFERSON UNION

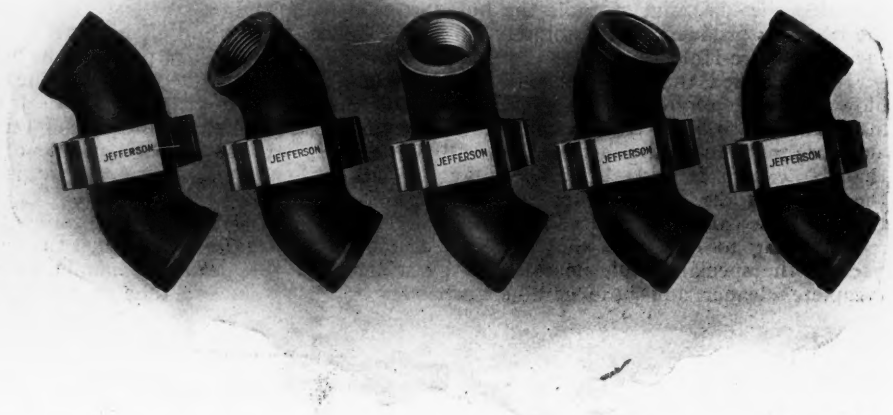


FIG. 2. POSITIONS POSSIBLE WITH JEFFERSON SWING UNION

Parts are of heavy construction and so designed that the ells can be connected to the pipes and the nut applied and tightened without disturbing them. Two styles of nuts can be supplied either of malleable iron or brass. These styles are the regular Jefferson nut or a specially notched nut shown in the accompanying cut, which can be set up with a hammer when used in close work.

This union has a wide range of use, at one extreme connecting parallel pipes in the same plane but slightly offset, and at the other extreme connecting pipes in the same plane at right angles with each other, while in the intermediate positions it can be used to connect pipes not in the same plane approaching one another at a great variety of angles.

Owing to the necessarily awkward line of construction followed for piping around both stationary and marine gas engines, automobile engines, and on locomotive work this union is especially applicable. By using the iron-to-iron seat these unions can withstand the high temperature of the exhaust from gas or gasoline engines, while the internal construction is in such easy lines as to obviate back pressure.

The materials used in the manufacture of these unions are selected with especial reference to their resistance to corrosion when being used in the neighborhood of salt water.

FRICTIONAL RESISTANCE

NOT until about 1800 was any special attention given to the subject of frictional resistance, and as usual in those days, the Frenchmen took the initiative. Coulombo was among the first who made extended research regarding the laws of friction and determined the coefficients of friction, which were published in 1821.

Some years later General Morin entered more deeply into the investigation of this subject under the direction of the French Government, the results of which were recorded in the Memoirs de L'Institute in 1833. To this day his writings are accepted as standard and we are indebted to him for the first enunciation of the laws governing friction.

When we consider that the apparatus by means of which Morin's laws were obtained consisted essentially of a traineau or sled, operated upon a rectilinear track, it is all the more remarkable that he should have obtained such standard results. Rotative devices are now used altogether which give very much more accurate determinations and modern scientists have spent much time in experimenting with various substances and alloys without arriving at any definite conclusions as to the frictional value of such alloys or the causes which occasion the variations shown in tests; indeed, there is a considerable divergence of opinion among scientists to account for these variations.

It is generally conceded, however, that metals have frictional individualities, and that certain compositions determine the frictional characteristics of alloys, and also that in certain alloys used for bearings, certain metals contained therein of low atomic value add to the frictional resistance. As for instance antimonial lead, with its small proportions of arsenic, copper, iron, sulphur, etc., will not give as good results as a composition of pure lead and antimony regulus. All industrial alloys have been developed empirically, and the practical mechanic has evolved from his own observations and experience a knowledge of these

facts, which have since been scientifically confirmed, and he knows that it is useless to look for the best results from metal made from such byproducts as antimonial lead, or which are gathered from the scrap pile, and he generally seeks for the best standard metals of known high uniform grade, although the cheaper products may show tentatively the same analysis.

The laws of friction as announced by General Morin were as follows:

1. The friction between 2 bodies is directly proportional to the pressure, i. e., the coefficient is constant for all pressures.

2. The coefficient and amount of friction, pressure being the same, are independent of the areas in contact.

3. The coefficient of friction is independent of velocity, although static friction (friction of rest) is greater than friction of motion.

Among modern investigators of these laws Prof. John Goodman obtained the following results on the testing machines of Thurston, Tower and Stroudley:

1. The coefficient of friction for moderate pressures and speeds varies approximately inversely as the normal pressure.

2. The frictional resistance varies as the area in contact, the normal pressure remaining constant.

FIG. 1. RUBBER BELT ON PLANER MILL SERVICE

3. At very low journal speeds the coefficient of friction is abnormally high; but as the speed of sliding increases from about 10 to 100 ft. a min., the friction diminishes, and again rises when that speed is exceeded, varying approximately as the square root of the speed.

Prof. Thurston, a modern American scientist, defines friction as "that force always acting as a resistance which is experienced when it is attempted to move one body upon another which is pressed into close contact with it."

Friction is generally supposed to be due to the interlocking of the asperities of the 2 surfaces and abrasion by tearing them off. General Morin in his experiments developed the fact that metals of like structure bearing one upon the other, as iron upon iron, and steel upon steel, produce greater friction than will metals of different structure, as iron on brass. Science has not yet produced any improvements upon the industrial alloys; nor evolved any laws which would guide or assist the ordinary layman in his attempts to improve on present products.

Every investigator of this subject recognizes the work done by Prof. Goodman and constantly refers to him as the highest authority; and among the industrial alloys he has unquestionably placed his seal of approval upon Magnolia Metal as possessing the lowest coefficient of friction of any of the many bearing metals he has experimented with, and calls special attention to the value of Magnolia in reducing wear and frictional resistance by filling in the interstices of the journal, thereby preventing the interlocking of these asperities and abrasion of metal, and increasing the contact surface of the journal and bearing.

While certain alloys may show tentatively the same tin, lead and antimony contents as Magnolia, there are important ingredients invariably omitted in such assays, nor does it show the foundry practice which purifies the metals and eliminates any traces of harmful impurities, and incorporates graphite into the mass.

NINE YEARS' BELT SERVICE, AND OUTDOORS IN THE DUST AT THAT

WHAT a belt can do when it is properly cared for is well shown by the experience of a firm in Ware, Mass., whose plants are out in all sorts of weather. The belts are not large, but the service is hard and the conditions of the worst.

Figure 1 shows a 6-in. 4-ply rubber belt which has been used to drive a 24-in. planer from a traction

FIG. 2. LEATHER BELT AFTER A YEAR'S SERVICE IN OUTDOORS SAWMILL WORK

engine, the driving pulley being 3 ft. diameter at 235 r. p. m. and the driven 6 in. diameter at 1400 r. p. m. with 16 ft. between centers.

Dirt, snow and water get on the belts all the time, making it hard work to keep them in running order.

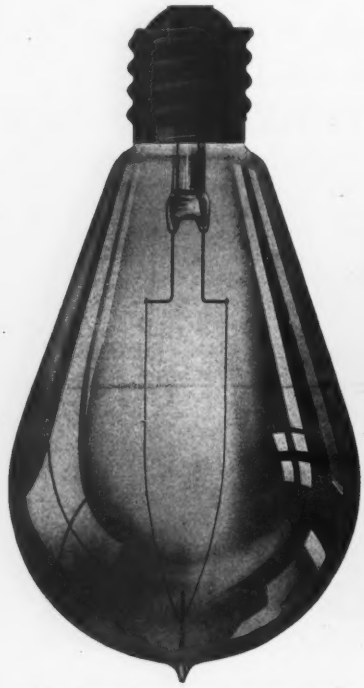
In Fig. 2 the belt is 14-in. double leather from a 6-ft. engine pulley at 180 r. p. m. to a 20-in. saw pulley at 645 r. p. m. on 25 ft. centers. The belt has been running a year in a portable sawmill, as shown, and the excellent condition is evident from the slack shown in the photograph.

Hoyt Bros., who are lumbering contractors, say that "We have used Cling-Surface since 1901 and find it the best of anything we have ever used. It is great as a preventer of slip and a protector from dampness. Before using it the cement would loosen in the laps, but we have no trouble with belts properly filled with Cling-Surface as they are moisture proof.

"We find it best to fill a new leather belt by painting both inside and out at first until the belt is thoroughly filled, and then use very little Cling-Surface whenever belt shows any slip. We find it saves belts and bearings a good deal on account of being able to run slack and in fact it has saved us belts and money as we do not have to stop and take up belts on account of slack."

HIGH EFFICIENCY AND ENDURANCE

THE Shelby Series Mazda lamp which is shown in the accompanying photograph is rugged and at the same time very efficient. In the photograph is shown the construction of the lamp. The filament is short and heavy; it is well supported at the ends and in the middle, which makes it one of the strongest, most serviceable lamps on the market. The efficiency of the Shelby Series Mazda lamp is from 1 to 1.25 watts per candlepower, compared with the efficiency of the old style series carbon lamp at 3.5 to 4 watts per candlepower.



THE SHELBY MAZDA SERIES LAMP

The cost of current and renewals for the Shelby Series Mazda lamp is less than half the cost of the current renewals of the carbon lamp. The secret of the high efficiency and excellent color value of the Mazda lamp lies in the fact that the filament, although much smaller, burns considerably better, therefore whiter and at a higher efficiency.

THE VANCE STEAM TRAP

FEW pieces of mechanism can claim today to be the result of the expenditure of so much real engineering skill and ingenuity as the steam trap. Always new ideas are being put forth, always improvements made; perhaps this is because of the important part that the trap plays in the operation of all steam connections, such as heaters, engines, presses, kettles, etc.

Some engineers prefer the thermostatic type, some the float and others the bucket. It is not proposed to discuss here the merits of the various styles, only to give details of one modern trap of the bucket type, which is meeting with much success.

The Vance steam trap has been on the market for a little over 3 yr. and the manufacturers state that where there is a large amount of water to be taken care of it has been demonstrated that one of their special traps will take care of it.

As will be seen by the sectional view Fig. 1, it is extremely simple, and all working parts are easily accessible by simply removing the bonnet A of the trap.

Condensation enters the trap at F and overflows into the bucket D, which, when nearly full, drops and opens the auxiliary valve C, relieving the pressure under the main valve E. The water pressure on the upper surface of the main valve then forces it from its seat and the water in the bucket above the low water line is instantly discharged. The bucket being relieved of its weight rises instantly to its former position closing both valves tightly, leaving the discharge tube H always full of water, thus forming a perfect water seal and preventing loss of steam.

It will be noted that the auxiliary valve C is attached to the winged guide by a slip joint G and is thus always guided true to its seat by the cage. This winged guide to which the auxiliary valve is attached is 1-16 in. less in diameter than the discharge tube, thus making it impossible for it ever to stick and prevent the bucket from operating.

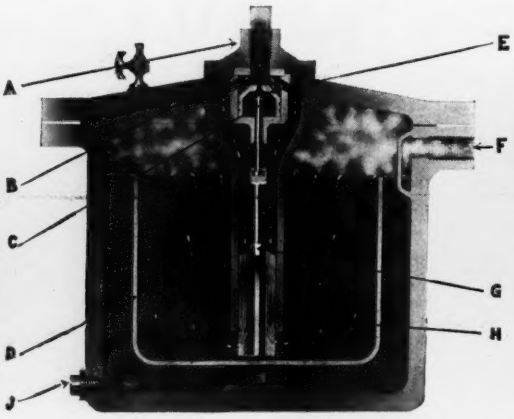


FIG. 1. SECTIONAL VIEW OF THE VANCE STEAM TRAP

FIG. 2. THE VANCE TRAP AS INSTALLED

One of the particularly notable features of this trap is this double valve arrangement which gives a large valve area. The advantages of this feature will readily be appreciated when it is understood what object the manufacturers had in view when this arrangement was incorporated in the design.

When a trap is sold of any given size, say 1-in., it is understood that it will take care of all condensation that can possibly be given to it by the 1-in. inlet. It is failure to get rid of this amount of condensation because of small valve area that causes annoying trap troubles with which all engineers are familiar.

A good trap should discharge in "gusts" and the moment steam appears the valve should close with a snap, for should it remain open for even a few seconds it will not be long before the valve seat will be destroyed, as the action of a steam blast upon the valve and its seating is even more destructive than a blast of compressed air cutting the seat every time it strikes it and making it impossible for the valve to close sufficiently tight to prevent dribbling—one of the worst of the troubles. This is successfully overcome in the Vance trap by means of the water seal in the discharge tube previously mentioned.

It will also be noticed that the valves being situated at the top of the trap are practically out of harm's way as far as becoming clogged with mud or scale is

concerned. The valve cage containing the main valve is attached to the bonnet of the trap and is thus readily accessible. The valve seat B is designed to be reversible when occasion requires; thus it gives double service before regrinding is necessary.

The manufacturer of this trap is the Geo. M. Newhall Engineering Co., 136 S. Fourth St., Philadelphia.

FOUR VALVE STRAINER

FOUR Valve Strainers, as the name implies, have 4 valves, 2 valves per set, one of which is hollow and in which is placed the strainer basket. When in use, the water is always passing through one of the strainer baskets entering the top, the other being, if necessary, cut out for cleaning purposes.

The body of the strainer is made out of one casting. The strainer is made in 2 types, one with the top drive and the other with the side drive; the side drive

FIG. 1. FOUR VALVE STRAINER WITH TOP DRIVE

FIG. 2. SIDE DRIVE ARRANGEMENT FOR FOUR VALVE STRAINER

being used on vacuum work where air leakage when cleaning is not permissible. On the side drive the screw that passes up through the lower valve is surrounded by a tube so that there can be no leakage through the threads of the screw that passes through the lower valve. For pressure work and service in which a small leakage of air can be neglected, the top drive being cheaper in construction, is generally employed.

In the condition shown in the illustrations, the water is passing through the right hand strainer, the left hand strainer being raised up and is ready to be removed for cleaning, which can be readily done by removing the cover. The strainer slips over the valve stem, the dirt is dumped out, the basket replaced, the cover put on again and the basket just cleaned is ready for service as soon as the one in service becomes clogged up.

The strainer is manufactured by the Liberty Manufacturing Co., of Pittsburg, the manufacturers of the Twin Strainer. The Four Valve Strainer is an excellent device to use in cases where the water does not contain large quantities of foreign matter and is recommended only for such cases.

CONTRACT HAS BEEN let to the Westinghouse interests for the construction of a new power house at Columbus, Ohio, for the Mt. Vernon Ry. & Lt. Co. The house will be of brick and concrete, the first installation being of 800 kw. and the final capacity 2500 kw.

INTERESTING DIE STOCKS

FEATURES of the No. 25B Beaver die stock shown below, will be interesting to users of die stocks, because of their practical value in saving time and labor.

The stock is built on the easy working principle, meaning narrow dies which recede to form the pipe taper. The friction of cutting is reduced by means of these narrow dies and as they recede, or open out, in cutting to form a tapered thread, they have less metal to remove with each turn, consequently each turn grows easier, enabling one man to cut a 2-in. thread.

It threads 1 to 2-in. pipe with one set of dies, by simply shifting a cam, which saves the time of changing.

A feature of this stock, in addition to not having to change dies, is the universal chuck which actually centers and grips all sizes of pipe by simply shifting a cam, thereby doing away with several loose bushings and the breaking of grip screws. It is complete within itself—no loose parts to change, keep track of, or get lost.

THE BEAVER 25B DIE STOCK

The maintainance of the stock is most economical. Since only one set of dies is used only one set must be purchased when dull, and the usual expense from broken grip screws and lost bushings is eliminated, also the load screw is a small separate piece for cheapness in repairing in case of wear.

This die stock is made by the Borden Co., Warren, O., and is only one of its line of interesting die stocks, covering all sizes as shown in its No. 11 catalog, which may be had on request.

IMPROVEMENTS IN ENGINE STOPS

AUTOMATIC engine stops, introduced in the latter part of the 19th century, have saved numerous lives and much valuable property, and improvement in them has been rapid. It has now become plain that in order really to protect there must be a speed limit which will guard against slipping belts, hence must operate independently of the governor or secondary governor. This makes the type attached direct to the shaft of the engine the most desirable.

If an electrical contact is used it should be so arranged that there is no possibility of loosening of connections or corrosion of contact surfaces or any other chance that shall prevent flow of current when it is

needed. If mechanical action is employed, it must be strong and positive enough to ensure operation however long the intervals may be between trippings.

In bringing out its engine stop and speed limit the Strong, Carlisle & Hammond Co. of Cleveland, O., has arranged to meet all these requirements and others. The stop itself is tripped direct from the shaft; provision is made to operate by either open or closed electrical circuit also to operate the stop valve mechanically. A positive hammer blow releases the stop valve, and there is no possibility of slipping or the valve creeping. The stop mechanism is of such design that any tampering with it will be detected by the man having the detecting device, hence its operative condition is always ensured.

For the electrical circuits a patented method of wiring has been devised which electrical engineers have pronounced perfect. The circuit closers are without binding posts and have silvered contacts, and no push buttons are employed.

As a special guarantee of high quality and effectiveness the Strong apparatus installed under the supervision of the representative of the Strong Carlise & Hammond Co. and on the force engaged in this work is Frederick S. Palmer, who for 7 yr. prior to his connection with this company had been expert for 2 of the best known stops on the market. He has had long experience among steam users and visited innumerable flywheel wrecks. Two valuable patents on methods of wiring have been assigned by him to the company, and his signal system for factory use which will be used in connection with the Strong stop took the highest award at the World's Fair in St. Louis. Mr. Palmer is well known throughout the country for his work in developing the engine stop, his many contributions to leading journals and his lectures before engineering societies.

GRAPHITE; ITS USE AND NATURE

GRAPHITE has been known to man as a mineral since the latter part of the 14th century, and is found in various countries of the globe in amorphous and crystalline form, which for many years have been mined and the different grades thus obtained used for various purposes. Natural graphite is always found associated with various impurities, such as sand, talc, mica, clay, etc., the specific gravity of some of its associated impurities being so nearly identical that it has been found quite impossible wholly to separate them by floating in water or air. Because of this recognized impurity content of natural graphite, the fact that Dr. Edward G. Acheson discovered processes for making soft, unctuous, Acheson graphite that is practically chemically pure, and therefore gritless, is of unusual interest to the industries of the world.

Progress made in developing the graphite industry at Niagara Falls has been truly remarkable and it may be said to be wonderful because man has learned how to make graphite of a quality far superior to that made by nature. Still, when we come to think of it, possibly we should not attribute so much wonderment to the electric furnace process, for it is evident nature, when she made graphite, had no choice of raw materials, while in the methods used for making Acheson graphite in Niagara Falls, man controls the selection of every ounce of raw material and the process of making during the entire time period of the electric furnace operation. Because of this full control of raw material and furnace operation, it has been found possible to impart to each grade of Acheson graphite certain definite chemical and physical properties, and thus give to the various grades of graphite made, the qualities essential to successful use in the field to which they are applied.

Thus, for instance, one grade is made as a dry cell filler; another is made as paint pigment; other grades are made for lead pencils, foundry facings, for electrotypers' use, etc., while grades having a guaranteed purity of at least 99 per cent are made for the purpose of lubrication. It is not always possible to apply graphite in powder form to the points where lubrication is needed, and in the development of the art associated with man's making of Acheson graphite, there has been a further development to assist industry and today it is possible to obtain these electric furnace graphites of high purity mixed with grease in the form of Gredag; mixed with oil in the form of Oildag; mixed with water in the form of Aquadag. No natural graphite is obtainable in all these forms for lubrication. The claim is made, and with good reason, that a graphite film will not break and permit the metals to seize or cut as will a film of grease or oil. These latter lubricants easily run away, but when Acheson graphite in one of the forms mentioned is used as a lubricant, it imparts a veneer or polish to the bearing which gives lasting lubrication, the endurance, efficiency and economy being surprising as compared with plain oil or grease lubricants.

Under these circumstances, and considering that the electric furnace gives us graphite that is practically chemically pure, it is not unreasonable to conclude that the era of successful graphite lubrication has opened, and that this most efficient lubricant is destined to have great popularity in all plants where the aim is to reduce the cost of the output.

LESSENING FIRE RISK

IN manufacturing, power, and similar industrial establishments a possible source of fire is oil—not illuminating oil, but that used for lubricating purposes. If oil drips or splashes out of bearings to the floor, and if the latter is of concrete, the oil saturates it, thereby weakening the mass and making the floor unsafe. If the floor is of wood, the dripping oil renders it highly inflammable. That fire insurance companies recognize this possibility is shown by the higher rate charged on buildings containing oil-lubricated machinery than on buildings housing machinery lubricated with plastic lubricants such as grease.

The ability of grease to "stay where it is put," to use an apt phrase employed by Adam Cook's Sons, manufacturers of Albany Grease, prevents either splashing or dripping of the lubricant. Consequently the fire risk is considerably decreased, to say nothing of the cleanliness secured. Thoughtful engineers recognize these advantages in the use of grease for lubricating purposes.

BUY SATISFACTION

SUCCESSFUL buying doesn't mean simply goods bought. It means getting something which you will like as well after using it as you do when considering it. It means saving in bills for material and labor; it means no complaints on account of shut downs and breakages; it means no irritating controversies with salesmen or makers. It means an employer satisfied with your work and your plant. It pays to buy satisfaction rather than trouble.

The satisfied feeling will last long after bills are paid and cost is forgotten. Unsatisfactory purchases because they were "cheap" will haunt you until they land in the scrap heap.

IMPROVEMENTS IN REAGAN STOKING DEVICE

IT IS difficult to keep up with the improvements which Keagan is always devising for his apparatus. Spite of the record for efficiency and capacity that has been made by this device, some chance for making it better is always being unearthed by the active brain of Mr. Reagan and at once he proceeds to put his thought into working form.

In studying the action of his stoking device, Mr. Reagan saw that by extending the tail of the stoker bar and curving it, a greater leverage could be gotten so that it would be more easily operated. He, therefore, made this change with the result that the new device stands

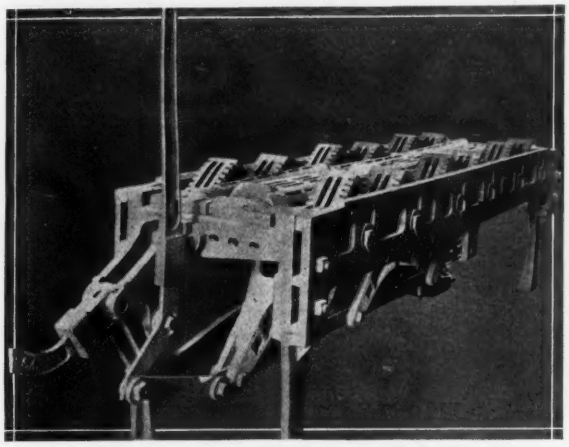


FIG. 1. REAGAN GRATE WITH CHOPPING BARS IN ACTION

when the stoking bar is in its flat position, as shown in Fig. 1, and when it is lifted as shown in Fig. 2.

The chopping bars are shown in action in Fig. 1 and stationary in Fig. 2. The chopping bars and the stoking

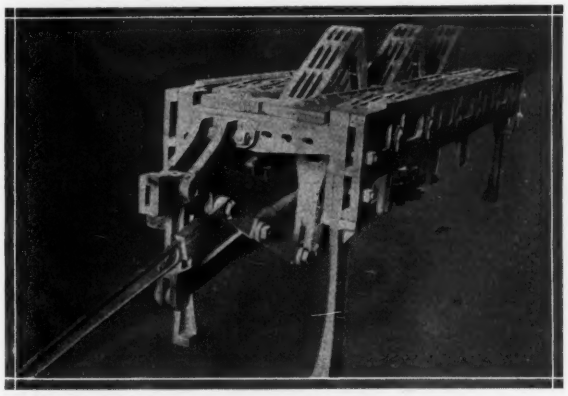


FIG. 2. REAGAN STOKER BARS IN ACTION

device are operated separately by the 2 levers shown, and under ordinary conditions both of them lie flat with the surface of the grate.

Another improvement consists in the mounting of the chopping bars. In the older design these were made with a square hole through the casting and were threaded on a square shaft. When a chopper needed renewing for any reason, it was necessary to take out the shaft. To avoid this, a thimble is now put on the square shaft with lugs cast on the chopping bar, so that it slips sidewise over this thimble and is held in place and operated by the thimble. By removing the partition between choppers a chopping bar can be slid to one side and drawn out and a new one slipped back in place without disturbing any other portion of the grate.

FIG. 3. NEW FORM OF REAGAN CHOPPER

By the use of the choppers and the stoking device the fire is kept in porous condition at all times, clinker is kept from forming and a high rate of combustion is made possible, at the same time giving high efficiency. Fig. 3 shows the new form of chopper and Fig. 4 the new form of stoking device separate from the rest of the grate.

$204,000,000 GOES UP IN SMOKE

OVER a million times during the past 10 yr. we have witnessed the thrilling sight of burning buildings. In the year 1889 this cost the nation $123,046,833; 10 yr. later the loss amounted to $153,597,830; while last year $204,000,000 worth of property was destroyed by fire. This constantly in-

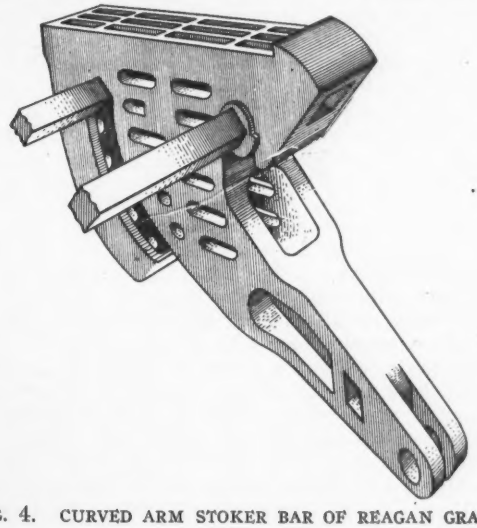


FIG. 4. CURVED ARM STOKER BAR OF REAGAN GRATE

creasing annual fire loss in the United States has induced engineers interested in fire protection to seek for all practical methods of lessening the danger of ignition and spread of flames. As a result of this, tile, vitrified facings, terra cotta, concrete construction and numerous other fire-resisting materials have been developed for use in all parts of buildings except the roof, while but few important improvements have been made in perfecting roofing materials, notwithstanding the fact that authorities claim that from 27 to 50 per cent of the conflagrations are the result of flames being communicated to adjoining buildings by burning sparks and embers falling on an inflammable roof.

One roofing, known as J-M Asbestos roofing, which is being largely used on factories and large buildings seems to overcome this objec-

tion, and is said to be so fire-proof that it will withstand the flame of a blow-torch for an hour without being injured. This roofing is made by the H. W. Johns-Manville Co., of New York, well known as manufacturers of asbestos products.

In making this roofing, several sheets of asbestos felt are thoroughly saturated with genuine Trinidad Lake Asphalt, well known as the most permanent waterproofing material. These sheets are then cemented firmly together with this asphalt, making one homogenous mass. This, then, constitutes an actual covering of stone, which, because of its all-mineral nature, not only offers to a building protection against fire, water, wind and weather, but which also naturally cannot rot, rust, melt, run or crack, and requires no painting to preserve it.

A handsomely illustrated catalog will be sent to any of our readers inquiring for it of the H. W. Johns-Manville Co.

CAPACITY AND POWER OF VENTILATING FANS

IN THE case of air movement the range of capacity and power of screw or propeller fans is subject to wide fluctuations, according to the resistance presented by piping systems or wind velocity. Minimum power and the maximum delivery for a given number of revolutions are secured only when there is no opportunity for interference of air currents and the fan delivers freely in still air. It is under these conditions that the properties of Davidson ventilating fans as presented in the accompanying curves, have been determined by the Massachusetts Fan Co., of Watertown, Mass.

Machines for producing air movement naturally divide themselves into several groups, each proving most efficient within certain limits of air pressure produced. When velocities and resistance are low the screw or propeller type best serves the purpose. Here the air is both received and discharged in an axial direction. For pressures ranging from somewhat less than one ounce per square inch up to a possible 12 to 16 ounces the peripheral type occupies the field. In this the air is received axially but delivered radially around the periphery usually into a spirally expanding case with suitable outlet.

Beginning within the range of 10 to 12 ounces the rotary blower, moving forward uniformly measured volumes of air, possesses the ability to create pressures ranging up to several pounds per square inch. The turbine blower, now in process of development, covers much the same field. For the production of still higher pressures the piston blowing engine and the air compressor successfully meet the requirements.

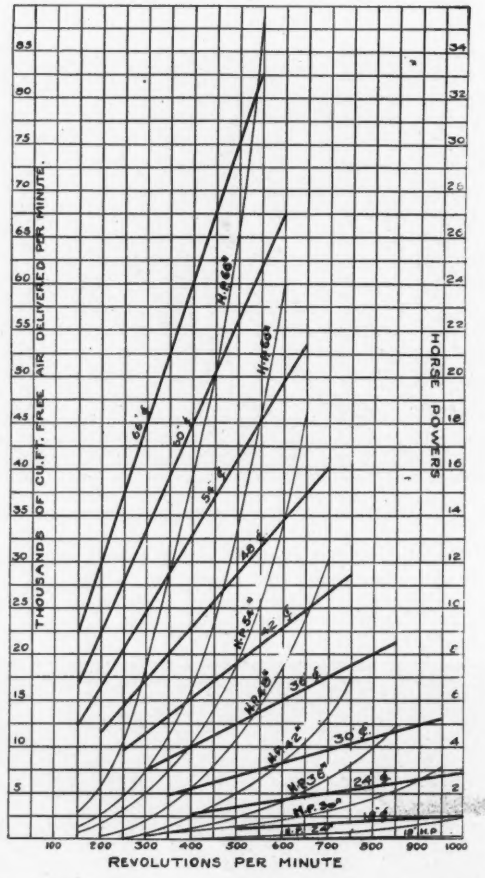
The effect of increased resistance through the extension of piping or the counter blowing of the wind is to throttle the discharge, thereby decreasing it, but at the same time increasing the power required to drive the fan. This is exactly opposite to the effect of resistance in the case of the peripheral discharge; here increase in resistance, which is equivalent to reduction in free delivery, decreases the work to be done, hence the power required. But even when the outlet is entirly closed considerable power—roughly 1/3 of that with full outlet—will be required to drive the fan within the case.

With the propeller fan on the other hand the decrease of resistance to free discharge increases the power required until the maximum must be expended when no air whatsoever is discharged.

In other words, in a peripheral fan the power is automatically adjusted, although only approximately, to the work actually accomplished in moving air, while the propeller fan becomes increasingly inefficient as the delivered volume diminishes. Hence it is far more vital in the case of the latter type that resistance should be reduced to a minimum.

SHIPPING COSTS

FREIGHT is one of the serious items that the manufacturer of power apparatus has to reckon with. With each shipper acting by himself and more or less in the dark there is no way but to accept such conditions as the railroads (usually working on a joint agreement) propose.



POWER REQUIRED AND AIR DELIVERED BY VENTILATING FANS

Only by organization and co-operation can the shipper hope to gain any concessions. Only by accurate knowledge of routes, conditions, rates and schedules can advantage be taken of the best present means of freight transportation. Both these things require attention, study and experience, all most easily obtained by means of an organized bureau whose business it is to serve those who maintain it. The heavy shippers, as being most interested will naturally take the lead in promoting such local bureaus, which by federation can become a great help to buyers as well as sellers. "There's strength in big numbers," and the gathering together of small as well as large users of freight facilities will result in advantages never before obtained and should materially decrease the expense of shipments and the even greater evil, the aggravation of poor service and slow delivery.

LEADERS IN POWER PLANT ENGINEERING

EDWARD T. ADAMS; A PRODUCT OF THE SHOP

IN his earlier days he faithfully carried the tin dinner pail, which was not quite as full as he would liked to have had it. As the shop paid for his technical education it came rather late in life, but he got it and then followed a short period in which he was instructor first at Leland Stanford Junior University and afterwards at Cornell University. From there it was his good fortune and that of the company that he went with the old Edward P. Allis Co., and was for many years computer or personal assistant for the late Edwin Reynolds, to whose brains and energy the original Allis Co. largely owed its existence.

During this period he was worked into the pumping engine business, and specialized in low lift pumping, designing during this period some of the largest and most efficient pumps of this class that have been built, notably the pumps for the 39th St. Station in Chicago and for numerous other similar stations in various parts of the country. The record of the 39th St. Station has been widely published, and engineers are familiar with the fact that these pumps are not only the largest which have ever been built, but gave a duty of approximately 150,000,000 ft. lb. per 1000 lb. of dry steam, which is in advance of 50 per cent in economy over any previous mark.

At the time of the combination of the Allis Co. with the Fraser-Chalmers and other companies, to form the present Allis-Chalmers Co., Mr. Adams had grown to be manager of the pumping engine department, which position he resigned to go with the Westinghouse Machine Co. at East Pittsburg, as engineer in charge of the gas engine division, in which position he had charge of the design of the present Westinghouse large gas engine. This engine was the first large gas engine built in this country for blast furnace and producer gas work, and it was as a result of the successful outcome of these machines that the steel corporation went so extensively into the gas engine business, and these engines were in fact chiefly the basis on which the present gas engine business of this country has been built.

After nearly 3 yr. with the Westinghouse Co. the Allis-Chalmers Co., having meanwhile changed management, Mr. Adams returned to the latter company as manager and chief engineer of the gas and mill engine department, later taking on also the management of the pumping engine division for the same company. When he went to the Allis-Chalmers Co. it had built an experimental engine of some 300 hp., modeled on German design, which was in operation in its own shops, but it was found impossible to secure orders from American customers, partly due to the prejudice of American engineers against the German design, and partly to the excessive cost to manufacture which this design entailed.

The solution of the problem was the design of the present Allis-Chalmers gas engine, by Mr. Adams, and during the past 5 yr. he has brought the business up until at the present time the Allis-Chalmers Co. is doing a large part of the total large gas engine business of this country. He built nearly 50 engines of a maximum capacity of 3000 kw. each, which is as large as has been built by any company in the world, and which at the time they were designed, were larger than anything which had been built either here or abroad. Part of this business, of course, was the famous Gary order of over two million dollars.

Not the least remarkable part of this great order and the part which added largely to Mr. Adams' abundant crop of gray hair, was the fact that at the time this order was taken the Allis Co. already had on its books in addition to this, over three million dollars in gas engine orders, all of which work was under way in the shop, but without a single engine of this type in operation to give any indication as to whether or not the design and construction which he had brought forth was to be successful. It is no wonder therefore that the prediction was freely made from one end of this country to the other that the gas engine business would either make or break the Allis-Chalmers Co. It is a record to be proud of that during his management, this department was one of the most successful and profitable of the company's business.

The last 3 months Mr. Adams has spent abroad, investigating the internal combustion engine, not only the gas engine, but also the Diesel engine, which is making such extensive strides in Europe. He reports that in the gas engine field our German friends are doing some very very interesting things. As a rule, German design is likely to be theoretical and complicated, and to carry all manner of ingenious but useless appendages, as for example the 3 different sizes of baggage racks which grace every German railway compartment. The medium size rack for medium size baggage, the toy rack for ladies' hand satchels, and the little peewee rack for canes and umbrellas, in place of one broad, substantial business-like rack for the combination such as any live American or English designer would supply.

Modern German gas engine designs, especially the designs on which they are now at work, are in marked contrast to the general German tendency. Competition in large gas engines in Germany has become exceedingly bitter, and the majority of the builders who were engaged in this line 3 or 4 yr. ago, are no longer building large gas engines. They have either ceased to bid or have been unable to make prices which could live in competition with prices made by the 3 builders who are now dividing between themselves this branch of German industry. These 3 great builders are at work on designs simpler even than anything that any American builder has put forth, and which have been cheapened in every direction to practically the maximum attainable point short of some new and radical departure in gas engine design. Thyssen, Erhart & Seymer and Nurnburg are all building gas engines beautifully finished in all vital points, but with rough finish or with finish entirely eliminated at all points where good finish is not vitally necessary to the machine's operation.

One no longer hears from the men who are active in this industry any of the foolishness and technical theories about stratification and what not which characterized the early days of the gas engine business in Germany. The live German builders have come distinctly to recognize what has always been recognized by American builders of heavy machinery, namely, granted that the thermodynamic base is essentially sound, that engine is best which is simplest.

Mr. Adams will bring to his future work in gas engine development not only his own experience and excellent ideas but those gained from his observation of European practice and it is certain that in the future as in the past he will be a leader in the development of his chosen field of work.

NEWS NOTES

DURING THE PAST FEW MONTHS Allis-Chalmers Co. has shipped 2 gas engine blowing units and 2 generator units to the Lake Superior Iron & Steel Corporation, each one of the units requiring 12 cars for its transportation and weighing approximately 1,000,000 lb. The gas engines are all alike, being twin-tandem 4-cycle type with 34 by 48 in. cylinders. Two engines connect direct to blowing tubs for furnishing blast and 2 other engines which have been shipped drive alternating-current generators of 1765 kilovolt amperes. Two other blowing units will soon be ready to ship.

IN TOLEDO, OHIO, a new power plant will soon be built by the Macomber Brothers Co., to be erected at West Woodward Ave., N. 12th St. and Wakeman St. Work will be started on the new structure this fall, the first installation having 110,000 sq. ft. of floor space at a cost of $125,000. The plant will be in the nature of a power building seeking as tenants those who desire small amounts of power.

STEPS HAVE BEEN TAKEN for the formation of a National Society of Engineering Draftsmen to include all branches and to encourage a higher standard of professional attainment among draftsmen as well as getting them acquainted with each other. A high qualification for membership will be established and the effort made to obtain recognition from every concern employing draftsmen. The officers chosen are E. Farrington Chandler, president; Wm. B. Harsel, vice-president, and Henry L. Sloan, secretary and treasurer. The headquarters are at 116 Nassau St., New York.

DODGE MFG. CO.'s annual outing at Winona Lake was held on July 30, races both serious and humorous, baseball, bowling, swimming and dancing making up the pleasures of the day. Over 2000 were in attendance.

MESTA MACHINE Co. held its 3rd annual picnic for employes at Homestead Park, Aug. 10. The entertainment of the day consisted of athletic events, including races, rifle shooting and baseball, followed by dancing in the afternoon and evening.

COMPUTER FOR THE Coast and Geodetic Survey is to be appointed from a Civil Service list and examination will be held for places on that list on Sept. 7 and 8 at the principal cities in the country. The salary is $1200 a year. Examinations will be held in mathematics, including geometry, algebra, trigonometry, and calculus, and practical computations on the use of logarithms and ability to make calculations quickly and correctly. Six hours will be allowed each day on the examination. Citizens of the United States 20 yr. of age or over are eligible and should make application on Form 1312 to be obtained from the U. S. Civil Service Commission, Washington, D. C.

REPORT OF THE OFFICERS of the American Supply Men's Association and the American Order of Steam Engineers for the Philadelphia convention held last June is now in hand and shows the receipt by the Supply Men's Association of $2400 from 74 exhibitors and the expenditure of $2331.24, the large items being for hall rent, booths, signs, secretary's expenses and refreshments, leaving a balance on hand of $68.76. There was contributed and raised by the American Order of Steam Engineers $1148.20 and $1084.16 was spent, the large items being for railroad tickets, boat ride, badges and refreshments, leaving a balance of $64.04 to be returned to the local councils. Next year's exhibit will be held in Philadelphia during June, 1911, the director of exhibits being H. G. McConnaughy, of the Dearborn Drug & Chemical Works, and the exhibit committee consisting of Hugh Edwards, of Garlock Packing Co., Philadelphia; Carl A. Dickel, of Cyrus Borgner Co., Philadelphia; G. Frank Duemler, of W. B. McVicker Co., New York; Jos. P. Manypenny, of Engineering Equipment Co., Philadelphia; Ellsworth A. Corbett, Corbett Supply Co., Trenton, N. J.; J. S. Swan, of the Roto Co., Hartford, Conn.; W. J. Gillespie, of Central Construction & Supply Co., Philadelphia; Willett R. Smith, Southern Engineer, Atlanta, Ga.; W. H. Davis, of the Diamond Power Specialty Co., Detroit, Mich.; Chas. V. Frick, Frick Grate Bar Co., Philadelphia; S. W. Anness, of Practical Engineer, Chicago; R. S. Bickett, of Parker Boiler Co., Philadelphia; J. M. Willetts, of Jos. Dixon Crucible Co., Philadelphia; E. M. List, of Vilter Mfg. Co., Philadelphia; R. B. Huestis, of The Power House, Toronto, Canada; A. L. Whittemore, of J. H. Williams Co., Brooklyn, N. Y.; Geo. Davis, of T. C. Warley & Co., Philadelphia; J. F. Boreland, of France Packing Co., Inc., Tacony, Philadelphia; H. A. Smith, of Philadelphia Grease Mfg. Co., Philadelphia; Harry Harmstadt, of Cancos Mfg. Co., Philadelphia; Chas. Curren, of O. F. Zurn Co., Philadelphia; W. Van Buren, of The Engineers' List, New York City, and Homer Whepley, of Strong, Carlisle & Hammond Co., Cleveland.

AT THE SEMI ANNUAL MEETING of the National Association of Cotton Manufacturers to be held at Hotel Wentworth, Portsmouth, N. H., Sept. 15 to 17, papers of interest on power plant topics will be read and discussed as follows: Economical Lubrication, Economizers and Draft, Illuminating Engineering, Natural and Artificial Draft, Producer Gas Engines, Renaissance of the Water Fall.

THE PHILADELPHIA HOUSE, Goodall Rubber Co., of the Peerless Rubber Mfg. Co., has recently been removed from 704 Arch St. to larger quarters at 19 North 7th St., to take care of increasing trade and to give better facilities for handling the company's business and for accommodating patrons.

GREEN ENGINEERING Co. has removed its Chicago office to the Steger Building, 39 Jackson Blvd., where it now occupies the entire 13th floor in the handling of its specialties, which include the Green chain grate stokers, Geco ratchet driven ash drags, water-backs and pneumatic ash-handling systems. The new telephone number is Harrison 1743.

WILLIAM J. A. BAILEY, who recently returned from a successful trip around the world representing a number of American manufacturers, is now preparing another business tour. He expects to leave this country early in the fall and will be gone about a year, visiting the leading commercial centers of the world. Mr. Bailey markets his lines in conjunction with permanent sales offices in the different countries, so that this trip would no doubt be of interest to manufacturers seeking foreign trade. His address is 32 Broadway, New York City.

THE L. S. STARRETT Co. whose factory is at Athol, Mass., has removed its Chicago store which is now permanently located in new and larger quarters at 17 No. Jefferson St. where friends are cordially invited to call and inspect its complete stock of fine mechanical tools. It will have even better facilities than formerly for favoring the trade with prompt and efficient service.

AFTER SEPTEMBER 5TH the main office of the Kline Advertising Agency will be at 222 Society for Savings Bldg., Cleveland, O.

THE STERLING LUBRICATOR Co. of Rochester, N. Y., is erecting a new factory for the manufacture of its Sterling force feed lubricators, which is expected to be in operation by the first of the coming year. The de-

mand for Sterling lubricators has increased so largely that the company has found it necessary to triple its output, and the new factory has been designed with this end in view.

BOOK REVIEW

SELF-TAUGHT MECHANICAL DRAWING and Elementary Machine Design by F. L. Sylvester; 230 pages, 218 illustrations, 5 by 8 in., cloth binding, price $2.

After a short discussion on instruments, geometrical problems and projections which are necessary to the understanding of drawings, the author takes up at once the making of working drawings and shows the elements of such work. While the use of algebraic formulas is of great help in the work of the mechanical draftsman, the reason for introducing a short chapter on that subject in a book on mechanical drawing does not seem quite obvious inasmuch as the treatment is not sufficiently full to be of much use to a person unfamiliar with algebraic methods.

The elements of trigonometry are treated somewhat in the same way, but the reason for this is more evident since the use of trigonometry in projections and in the handling of triangles is frequent and almost necessary. Elements of mechanics are likewise taken up and strength of materials in brief chapters which give a fair idea of the application of these subjects to machines. Cam design shows the method of working out the shape of a cam and of making the working drawing for it.

Sprocket wheels and gearing follow, then bolts, studs and screws, couplings and clutches, a chapter on shafts, belts and pulleys.

The work is elementary and while it treats the subjects that are usually made a part of a course in mechanical drawing and machine design, gives hardly sufficient material without other exercises than those given in the book to make one proficient as a draftsman or as a designer. It is a good first book, but one using it as a course of self-instruction would need considerable additional material.

METAL SPINING is the title of one of the Reference Series issued by Machinery and gives condensed information on the principles of metal spinning, and on the tools and methods used. It shows the beautiful work which can be done by this process, and tells how to accomplish it. It can be had of the Industrial Press, 49 Lafayette St., New York City at a price of 25c.

CONCRETE FROM SAND MOLDS is the title of a new book of 150 pages, by A. A. Houghton, showing methods of making up molds for the casting of special concrete forms. Directions are given for the construction of these molds, for the mixing and preparing of the sand and for the use of clay, plaster, and concrete, also the use of cores and how to set them. The price of the book is $2 in cloth binding.

ENGINEERS AND POWER PLANTS OF GREATER NEW YORK are completely listed in the new directory, published by the Engineering Directory Co., of 41 Barclay St., New York City. This directory is handsomely gotten up, with attractive style, and conveniently arranged lists. These include an alphabetical list of steam and electrical plants in the 5 boroughs of Greater New York, giving their full equipment and names of fireman and engineer in charge; a classified directory of steam specialty manufacturers and supply firms giving New York office addresses and the telephone numbers; and an alphabetical list of licensed engineers employed in New York with residence addresses and where they are employed.

Besides these lists there is an official directory of the Engineers' Associations of the United States, and particularly of New York City, giving the general officers and the addresses of the secretaries.

Useful information in the form of pointers for the engine room, the boiler room and the electrical plant take up a number of pages, and are in convenient question and answer form. It is a book which will be useful either to engineers or the manufacturers of power plant apparatus.

STEAM TURBINES, by Walter S. Leland, Chicago, 1910. Cloth, 7 by 10 in., 135 pages, illustrated.

This is a reference work on this popular type of prime mover, starting with the fundamental principles and reviewing the types of turbines, installation and performance, the action of single stage impulse turbines, such as the De Laval, compound impulse turbines such as the Curtis, Terry and Sturtevant, and re-action turbines such as the Westinghouse-Parsons and the Allis-Chalmers.

Governing of turbines is discussed in the last chapter, showing the methods by throttling, by varying the number of nozzles in use and by varying the time of admission. The illustrations are of current American machinery and show the details of construction clearly. It is a book that is free from mathematics, well arranged mechanically and with correct information on the latest developments and types of machinery. The price is $1.

ORNAMENTAL CONCRETE WITHOUT MOLDS, by A. A. Houghton, New York, 1910, 125 pages illustrated, cloth, 5 by 7 in., price $2. This is a practical treatise explaining a system of molding ornamental concrete units by a system which avoids the use of molds, and therefore greatly cheapens the cost of construction. The different sections take up the construction of templets, preparing of concrete and operating the templets in making of special forms; among these details are bases and capitals for columns, pedestals and piers, urns and vases, balls, posts, seats and benches, basins and lavatories, and ornamental moldings. The book is complete on the subject and will be found of value to those interested in concrete structural work.

ELECTRIC WIRING, by Joseph G. Branch. Chicago, 1910, 275 pages, 5 by 8 in. in cloth binding; $2.

The author deals not only with wiring, but with many things in the electrical field which are germane to the subject. After a brief resume of definitions and principles, which is rather too brief to be effective, he classifies circuits and gives the different ways that apparatus may be connected, how to run the circuits, to figure the size wire needed and to install the wiring for efficient working and in conformance with the Underwriters' requirements. Alternating as well as direct current circuits are treated, and wiring for railways, power plants, telegraph, telephone and wireless telegraphy. It is written in question and answer form, in simple language and has numerous but not well printed tables.

CATALOGS

BULLETIN NO. 267 from the American Blower Co. gives in detail the construction and method of operation of Detroit steam traps and Bulletin No. 273 covers the same ground for the A B C pipe coil heater.

FROM THE SPRAGUE ELECTRIC CO. come interesting books describing first the Sprague flexible steel armored hose for air drills, water and steam, showing also the couplings used with this, another on electric fans showing the alternating-current type as manufactured for all kinds of uses, and a third on single and polyphase induction motors showing in detail the construction of the different types, how variable speed is obtained, the

construction of each part, the controllers used and the sizes and dimensions of the different machines. Single-phase motors are also shown from ¼ up to 15 hp. Bulletin No. 600 is the one devoted to the single and polyphase induction motors.

BRISTOL'S RECORDING INSTRUMENTS are well illustrated in the Index Bulletin No. 150 just from press from the Bristol Co., Waterbury, Conn. It is a complete photographic record of the instruments made by the Bristol Co., and includes pressure gages, vacuum gages, water level gages, thermometers, pyrometers, voltmeters, ammeters, wattmeters, speed recorders and time recorders.

"DIAMOND" FURNACE REGULATOR as manufactured by the "Diamond" Power Specialty Co., is designed to control the damper and the stoker, closing down the damper and slowing up the stoker when pressure gets too high, and reversing the process when the pressure drops too low. It is described in a booklet which can be had by writing to the Diamond Co.

COMPLETE SERIES INCANDESCENT Lighting System of the General Electric Co. is described in bulletin 4718.

The illustrations include Mazda Lamps for street lighting with various forms of reflectors and suspension insulators, street system brackets, constant current transformers, panel boards, socket cutouts and ornamental poles, as well as complete dimension and connection diagram and illumination curves. In the cities and larger towns, the Mazda series lamp can be operated upon the same circuits as arc lamps, and can, therefore, be very effectively and economically used for intermediate lighting.

Bulletin No. 4738 describes three sizes of polyphase, 60-cycle generators for use in small isolated plants. These generators are of the belt driven revolving armature type, and are designed for service at any power factor between 0.8 and 1.0. They range in capacity from 7½ to 25 kw. and are furnished for 120, 240, 480 and 600 volts.

In Bulletin No. 4736, entitled "Lightning Arresters," are described various types of arresters for alternating and direct current—high and low voltage circuits. These arresters are described and illustrated in considerable detail, and the publication will be of interest to all central station managers.

Bulletin No. 4727 illustrates and describes in more or less detail two types of the General Electric Co.'s sewing machine motors which may be easily applied to any of the standard sewing machines of either drop head or stationary head types. These motors are intended for ordinary domestic use, and are made for alternating and direct current of standard voltages.

WHERE CONDENSATION from a surface condenser or returns from heating or drying systems form a considerable part of the boiler feed supply, it is often necessary to make up the full amount of feed water required by the boiler by adding water which is of a scale-forming or corrosive nature. On account of the disproportionately large cost of putting in a softening system of the usual type for this small amount of water it is usually fed to the boilers without treatment, with the result that scale is formed in the boilers. This problem has been attacked by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa., in the recently published Engineering Leaflet No. 7, entitled Combination Feed Water Heaters and Softening Systems, which describes an apparatus designed for plants in which such conditions obtain. This pamphlet should prove of interest to all engineers having to do with steam plants where scale-forming water is encountered.

FROM THE National Electric Lamp Association we have received a little book prepared by the Engineering Department telling about carbon, Gem, Tantalum and Mazda incandescent lamps and showing the illuminating power, life, and energy per candlepower in the different styles and sizes. It is a valuable book for anyone who has to do with the lighting of buildings and can be had by application to the Engineering Department, N. E. L. A., 4411 Hough Ave., Cleveland, Ohio.

CROSBY SPRING SEAT VALVES are interestingly shown in a series of plates with portfolio cover recently sent out by the Crosby Steam Gauge & Valve Co., of Boston, Mass.

GENERAL ELECTRIC CO. has recently issued bulletin 4752, illustrating and describing Rectifier Sets, Luminous Arc Lamps and all necessary auxiliary apparatus for complete Series Luminous Arc Rectifier Systems.

The bulletin is fully illustrated and shows views of the exterior and the mechanism of the Luminous Arc Lamp, as well as the Series Vertical Carbon Flame Arc Lamp for operation in series with Luminous Arc Lamps. A complete set of dimension diagrams of the various apparatus and a partial list of actual installations are also included.

THE BELT BOOK is full of interesting material. It is interestingly written, it tells about things that help in running the plant and it is attractively put together. It is on the treatment of belts and ropes for service and profit, and is directed at the engineer or superintendent who has charge of belts and rope drives. It is a book of 90 pages, well indexed so that convenient reference can be made to the information contained. A copy can be had by writing to the Cling-Surface Co., 1032 Niagara St., Buffalo, N. Y., and telling them that you saw it described in Practical Engineer.

THE OHIO BLOWER CO., of Cleveland, Ohio, which manufactures the Swartwout steam specialties, has issued a pamphlet describing the new Swartwout automatic safety water gage. The features are a removable valve and valve casing, independent gage bodies offset so that the glass can be swabbed out without removing it from the fittings and a valve which is self-regrinding and self-cleaning. The pamphlet tells all about it.

LOTHROP'S BELT AWLS is a device which makes the hole in the belt, puts the end of the lace through and gets it where you want it. It saves all the bother of a belt punch and of fussing to get the lacing through the hole. It will cut a large or a small hole, as required. Greene, Tweed & Co., 109 Duane St., New York, are the makers and are sending out a card which gives an interesting description.

HOW TO SAVE FUEL is the striking title of a piece of advertising matter coming from the Dodge Mfg. Co., Mishawaka, Ind., and describing the Eureka water softener and softening system.

HOW TO REDUCE the Expense of Selling Machinery is the title of a pamphlet in which the Geo. H. Gibson Co., advertising engineers, Tribune building, New York City, describes improved methods for promoting the sale of machinery by means of educational work and advertising. Hints are given concerning the writing of circulars, catalogs and advertisements, of treatises and text-books, and of descriptive articles for the technical papers, that will be suggestive to anyone who is responsible for the

sales promotion of products of an engineering or mechanical nature. Valuable tables and charts are also given showing the mailing weights of pamphlets and the relation between technical journal circulations and the price of advertising space.

TO FAMILIARIZE the general public with the character of graphite, the United States Graphite Co., of Saginaw, Mich., has issued 2 interesting pamphlets, Graphite Mining in Mexico and Interesting Facts About Graphite Paint. The typographical and illustrative features of these publications are in keeping with the excellent character of the text and they may be had on application to the company.

HEAT ECONOMY IN PAPER MILLS is the title of a pamphlet just issued by the Green Fuel Economizer Co., which gives an interesting discussion as to the most economical methods of utilizing heat in paper mills, and points out that contrary to the usual custom of using high pressure engines in order to have exhaust steam available, it is possible to obtain better plant economy by using high efficiency condensing engines or turbines, and heating the water necessary in the mill by means of a fuel economizer.

In one test quoted, the conditions are rather unusual. The economizer raising the temperature of the water only 20 deg., but due to the enormous volume passed through it, this comparative slight rise in temperature is equivalent to a saving of $2,743 a year in the fuel bill. Photographs of a number of recent installations are shown as well as a number of typical layouts of economizers in the paper mills. Copies of this publication can be had free of charge by writing to the Green Fuel Economizer Co., Matteawan, New York.

RICE & SARGENT Corliss Engines as made by the Providence Engineering Works, Providence, R. I., are fully and beautifully illustrated in Bulletin S75 issued by the works. It shows details of the cylinder and guides, valves and stems, the valve gear, and its operation—and this valve gear, by the way, is a novel one—the dashpot, the governor, main generator bearing, and other parts of the engine. The book is attractive as well as instructive and is worth while sending for.

L. J. WING MFG. CO., of New York City, is issuing a new bulletin, No. 7, in which it describes the Typhoon turbine blower for mechanical draft systems and shows the application to different types of boilers.

MODERN ORE & COAL HANDLING MACHINERY is the title of a handsome book issued by the Brown Hoisting Machinery Co., of Cleveland, Ohio. It shows in fine halftone prints the character of machinery installed for the large ore handling plants of the Great Lakes and of the different steel works throughout the country, also the conveniences for coal handling which have been installed at coal docks and storage bins in various plants and power houses. To anyone who has the matter of ore or coal handling to deal with, this book will offer many suggestions and ideas which will be found available in future work.

BULLETIN NO 11 of the Engineering Department of the National Electric Lamp Association, Cleveland, Ohio, tells of the Mazda street series lamps and shows the different sizes, candlepower, lighting performance, life and the illumination given. Illustrations show the different styles made and the distribution chart for light about the filament.

H. W. JOHNS-MANVILLE CO., of New York City, describing its J-M dry batteries, issues a folder showing the method of connecting such batteries in series and in multiple series for ignition of gas and gasoline engines. The battery is made in both square and round case and is warranted to give entire satisfaction.

THE INDUSTRIAL INSTRUMENT CO., of Foxboro, Mass., is placing on the market a line of standard automobile gages for showing oil pressure, water circulating pressure, boiler and fuel pressure on steam cars, pressure in illuminating gas tanks, the air pressure forcing fuel to the carbureter, and other uses. These are made with standard and with eccentric dials for use on dashboards. Illustrations and description are contained in Bulletin No. 36, issued by the company, which has also descriptions of drain cocks, priming cups and tire pressure indicators.

FROM J. THOMPSON & SONS MFG. CO., of Beloit, Wis., come 2 bulletins: No. 26, describing the Thompson suction gas producers of water sealed type, which have no grates, no clinkers and no dust; No. 28, describing the Thompson automatic gas engine for producer or natural gas.

HIGH GRADE PACKING for all conditions of service is the kind illustrated and described in the Engineer's Catalog issued by the New York Belting & Packing Co. At the beginning of the catalog the fact too often neglected in operating plants is stated, that "no packing is suitable for all conditions," and that a packing should be chosen best suited to the work required of it. For this reason the expert service of the staff of the company is placed at the disposal of engineers for solving any difficult problems or meeting any unusual conditions, but the catalog, which is a fit representative of the high grade products of the company, shows packings suitable for any conditions ordinarily met with in power plants. Even to list the names would take more space than is desirable but there are a number of diagonal expansion packings for different pressures and liquids, ring packings made up with different combinations of fabric and rubber, hydraulic packings of different constructions, combination packings for hard conditions such as uneven and scored rods, sheet packings with and without wire insertion, asbestos and special superheat packings for high temperatures, gaskets in cut, moulded and tabular forms, and pump valves of all degree or hardness for various conditions. The catalog is one from which a packing can be chosen understandingly and gives a comprehensive idea of what packing to use for any given case. A copy can be had by writing to the company at 16 Warren St., New York.

CATALOG H of the Ohio Brass Co. deals with valves and steam specialties. The cover design is striking but the designer has avoided any incongruous feature and has produced a most artistic introduction to an attractive book. Radiator valves, check and globe valves, angle valves, never-leak gage cocks, ball bearing glands for water gages, self-closing gage fittings, pressure regulating valves, are among those illustrated and described. These specialties are worth knowing about and the information can be had by asking the Ohio Brass Co., Mansfield, Ohio, for catalog.

STEAM HEATING by means of steam at atmospheric pressure is a system devised by the American District Steam Co. and which is adapted to either individual boiler plant or central station heating plants. The name "Atmospheric" is used for this system to distinguish it from pressure or vacuum systems. It differs from the ordinary system in that steam is supplied at the top of the radiator through a graduated valve which can be so set as to supply steam to any desired portion of the radiator up to 85 per cent of the total surface, the rest of the radiator acting as hot water heating surface. Condensed

water passes into the return piping through an elbow at the bottom. The principle of this system and the details by which the operations are carried on are interestingly and fully described in Catalog No. 119 issued by the American District Steam Co., of Lockport, N. Y.

WIDE FIELD OF APPLICATION of the polyphase induction motor is due to the many advantages inherent in this type, prominent among which are its simplicity, high efficiency and the small amount of attention which it requires. Bulletin 4751, recently issued by the General Electric Co., is devoted to various types of its induction motor. The bulletin contains illustrations and descriptions of the design and construction of the skeleton frame motor of different sizes, and describes a vertical motor which can be furnished when this form is advantageous. General Electric induction motors can be constructed for more than one speed, if desired; are made for various frequencies and voltages, and for 2 and 3-phase circuits. The bulletin contains illustrations of starting devices for use with these motors, and also of various parts composing the motor.

ENGINEERS WHO HAVE TO look after shafting (all of you who haven't to do this please hold up your hands) will find the pamphlet on Shaft Lubrication, issued by the Keystone Lubricating Co., Philadelphia, worth while sending for.

FROM THE TRIUMPH ELECTRIC CO., of Cincinnati, O., comes an interesting bulletin No. 391 showing the Triumph direct current steel frame motors. It gives complete details in regard to them and is fully illustrated.

IN A 96-PAGE BOOK entitled High Efficiency of Centrifugal Pumps the De Laval Steam Turbine Co. of Trenton, N. J. has brought together some 75 charts, diagrams, photographs and a vast amount of engineering information relating to such subjects, as ways and means for testing centrifugal pumps; charts of the results of such tests; the interpretation of these charts for the purpose of the engineers, etc. The book also discusses the relative importance of different features of pump design, such as accessibility, the influence of impeller, design upon the efficiency, the desirability of diffusion vanes, methods of preventing leakage between the discharge and suction chambers, the use of suitable bushings, sleeves, etc. to prevent corrosion of important parts, the manufacture of pumps to limit gages so that all parts are strictly interchangeable, balancing of multistage pumps, and the design of bearings for high speeds. It then takes up the adaptation of centrifugal pumps for all methods of driving and classes of service. Characteristics are shown for many centrifugal pumps. In each of these curves the conditions for which the pump was designed are also indicated, to illustrate the accuracy with which characteristics can be predetermined by the designer. Valuable suggestions are given for the drawing up of specifications and for testing pumps, to ascertain whether or not specifications have been made. In this connection it is stated that the De Laval Steam Turbine Co. guarantees beforehand the characteristics of the pumps built by it and subjects each pump to a thorough test at the works. The purchaser is invited to witness this test and a full report is supplied to him. This book will undoubtedly prove of interest to anyone having to do with pumping machinery in any way.

IN A TREATISE issued by the Stark Rolling Mill Co., Canton, O., are set forth, clearly and concisely, the facts concerning corrosion and rust, how and why they differ, their causes and what should be done to overcome them.

Some interesting comparisons are made of old-time iron with modern iron and steel which make clear the fact that the degree of purity, homogeneity and density largely govern the life of iron and steel. The results of many comparative tests are shown by tables and illustrations, and these results will undoubtedly be of great value and interest to sheet metal users everywhere. No attempt is made to delve deeply into chemistry nor the fine points of metallurgy. The simplicity of the English is a prominent feature particularly when one considers the technical nature of the subject matter. The many uses to which a rust-resisting product like Toncan Metal is adaptable are described and illustrated. Illustrations throughout are fine halftone reproductions of photographs; the printing is in 2 colors, with the buff cover embossed in French vermillion, altogether as attractive a piece of painting as one would care to see. Any person interested in the subject can obtain a copy by writing to the Canton offices.

JUST WHAT METHODS to employ for getting coal to the boilers and removing the ash are problems which confront every engineer, and many times he may desire to see the layout and arrangement of devices for doing this class of work in the most economical plants of the country. Such a desire may be gratified by writing to The Jeffrey Manufacturing Co., Columbus, O., for the booklet recently issued entitled "Coal and Ashes-Handling Machinery in Power Plants." This is a book of 75 pages, handsomely illustrated with halftones and complete line drawings describing in detail the coal and ash-handling equipment of many of the leading power plants of the country.

GENERAL ELECTRIC Co. has recently issued bulletin 4750, describing standard couplings which have been found by experience to fill all requirements, and are adapted for coupling electrical apparatus together, or to other machinery. The types dscribed are the Leather Link Flexible Coupling, Laced Belt Coupling, Rubber Buffer Coupling, and Flange Coupling. All of these will run equally well in either direction. The bulletin is fully illustrated and contains dimension diagrams of the various types.

TRADE NOTES

WAGNER ELECTRIC MFG. CO., of St. Louis, has on hand a considerable list of new and second-hand motors which it is offering at exceptionally low prices. These are described in Bargain List No. 13 recently received.

THE KNIGHT POWER CO., of Provo, Utah, recently placed an order with Allis-Chalmers Co. for the hydraulic turbines to be used in its hydro-electric development at Heber City. There will be 2 1650-hp., 514-r. p. m. single horizontal turbines operating under a head of 170 ft. These turbines will be identical except that different material will be used for the runners of each turbine. The power company wishes to satisfy itself as to certain points and has ordered 1 runner to be made of bronze and the other of cast iron. The result of this comparison will be watched with considerable interest. Another interesting feature is that the turbines will not be provided with governors. A regulating cylinder operated by the penstock pressure which can also be controlled electrically from the switchboard or mechanically from the turbine will be used ordinarily for regulation. In case of emergency a direct mechanical gear can be placed in operation.

IN THE REPORT of the exhibits at the Massachusetts State Convention, the display of the C. E.

Squires Co. was accidentally omitted. This was made by the Evans Mill Supply Co. of Boston, and C. E. Squires, president of the C. E. Squires Co., was also present. The exhibit included a full line of Squires improved steam traps, and 2 miniature traps which were operating under 60 lb. air pressure without the escape of air. As the entire apparatus weighs only 16 lb., this showing was remarkable. Mr. Squires made the trip from Cleveland, O., to Lowell, Mass., in his automobile especially to attend the convention.

SWARTWOUT CAST-IRON EXHAUST HEADS, manufactured by the Ohio Blower Co., of Cleveland, Ohio, have recently been purchased by Peck, Williamson Heating & Ventilating Co., Cincinnati, Ohio; American Warming & Ventilating Co., Pittsburg, Pa.; Glenlyon Dye Works, Saylesville, R. I.; National Tube Co., Pittsburg, Pa.; Imperial Tobacco Co., Winston-Salem, N. C.; Kellogg Toasted Corn Flake Co., Battle Creek, Mich.; Sommers Bros. Match Co., Saginaw, Mich.; Edge Moor Iron Co., Edge Moor, Del.; Central Union Gas Co., New York City; Barrett Mfg. Co., Elizabethport, N. J.; Wichita Water Co., Wichita, Kans.; E. M. F. Co., Detroit, Mich.; and Goodlander Milling Co., Fort Scott, Kans.

Also orders for Swartwout Centrifugal Separators have been placed with the Ohio Blower Co. by Charlotte Mfg. Co., Charlotte, Mich.; Eberts & Bros., Jeffersonville, Ind.; McMinnville Crystal Ice & Fuel Co., McMinnville, Tenn.; Garfield Woosted Mills, Passaic, N. J.; Emporia Mfg. Co., Emporia, Va.; Sommers Bros. Match Co., Saginaw, Mich.; Manning Oil Mill, Manning, S. C.; M. A. Snyder, Bloomsburg, Pa.; Louisville Lighting Co., Louisville, Ky.; Hochgreve Brewing Co., Green Bay, Wis.; Cleveland, Youngstown & Eastern Ry. Co., Chagrin Falls, Ohio; Sidney Novelty Works, Sidney, N. Y.; L. A. Becker Co., Chicago, Ill.; The Hartman Stock Farm Co., So. Columbus, Ohio; S. M. Price Machinery Co., Norfolk, Va.; Harris Granite Co., Granite Quarry, N. C.; Goodlander Milling Co., Fort Scott, Kans.; North American Smelter & Mines Co., Golden, Colo.; and the National Coal Co., Byesville, Ohio.

AS SHOWING THE PROGRESS in handling high electrical potentials, a transformer has recently been shipped by the General Electric Co. to R. Thomas & Co., East Liverpool, Ohio, for testing transmission line insulators. It has a capacity of 250 kw., and will run with primary voltage of 1150 or 2300, and with secondary voltage of 400,000. The floor space occupied is 5 ft. 7.5 in. by 10 ft., the height from floor to top of lead is 16 ft. 9.25 in., and the net weight is 20,000 lb.

LAGONDA MANUFACTURING CO., of Springfield, O., announces that the demand for its Weinland Boiler Tube Cleaners has been so great that it has been forced to increase the size of the plant. There has accordingly been added a new wing very nearly as large as half of the former plant. This new building is of concrete construction with slate roof, well lighted and ventilated. The stock and tool-rooms have been removed from the old plants into the new addition and the space formerly occupied by these departments equipped with new automatic machine tools which will meet the increased demand for the products and give prompt deliveries. The Lagonda Mfg. Co. reports that for the last 6 months it has been running night and day in order to keep up with orders.

AS EVIDENCE of the demand for a reliable high-speed engine free from vibration and having good steam economy, the American Engine Co., of Bound Brook, N. J., reports the following recent sales of the American Ball Angle Compound engine: St. Geo. Pulp & Paper Co., Norwalk, Conn.; Bates & Clark Co., Seattle, Wash.; Racquette River Paper Co., Potsdam, N. Y.; Wyman, Partridge & Co., Minneapolis, Minn. (2 units); Weston Electric Light Co., Weston, Mass. (2 units); Amityville Electric Light Co., Amityville, N. Y.; Children's Vehicle Corporation, E. Templeton, Mass. (2 units); Endicott Building, St. Paul, Minn.; The Gregg Co., Newburg, N. Y.; Pratt-Read & Co., Deep River, Conn.; Fulton Co. Gas & Elec. Co., Gloversville, N. Y. (2 units); United Gas Improvement Co., Philadelphia, Pa.; Utica Willowvale Bleaching Co., Chadwicks, N. Y.; Winchester Repeating Arms Co., New Haven, Conn.

RELIABILITY AND SATISFACTORY service given by Marsh pumps are well illustrated in the following letter received by the English Iron Works Co., of Kansas City: "You know that personally I would not use any other pump than the Marsh. We used to have so much trouble at the packing house with pumps having outside cutoffs, some of them having 7 or 8 different moving parts that the coal dust and dirt used to get in and cause undue wear, making lost motion and we were always in trouble, but since we have started to use the Marsh pumps at both the packing house and here at the plant (our cold storage plant) we have never had any pump grief; in fact when we built this plant I put everything in in duplicate so as not to get stuck, and the Marsh pumps that were started up in 1901 when this plant commenced to operate are now running, having run 24 hr. a day since that time with never a shut down except to pack them occasionally; in fact we have never started up our duplicate pump equipment except one brine pump when we were packing the one we usually run. So far as my idea goes this is the only pump on the market, and I would not consider other makes at very much less price. Yours truly, W. H. Underwood."

SPEAKING OF HOT BEARINGS, the United States Mica Co. of Chicago sends the following convincing testimony received from the Hollingsworth & Whitney Co. of Waterville, Me.: "We have used quite a bit of your Mica Flake Lubricant and find it far ahead of anything we have ever used for cooling hot bearings. Mica Flake brings the hot bearing down very quickly. We shall continue its use as it seems to fill a long felt want."

YORK MFG. CO. reports the following list of sales recently made: United States Aluminum Co., New Kensington, Pa., 1 6-ton refrigerating plant; Grant Hugh Brown, Goshen, N. Y., 1-ton refrigerating plant; United Iron Works, Oakland, Cal., 1-ton refrigerating plant for Lincoln Hardware Co., Lincoln, Cal.; Empire Scale & Fixture Co., Jacksonville, Fla., 1 4-ton refrigerating plant for R. H. McDonald, Daytona, Fla.; Lewis Brothers, Newark, N. J., 1 20-ton refrigerating plant; Lancaster Engineering Co., Denver, Colo., 1 15-ton ice making plant for Garrison Ice Co., Goodland, Kan.; The Mohican Company, Waterbury, Conn., 1 8-ton refrigerating plant for store; United Iron Works, Spokane, Wash., 1 2-ton refrigerating plant for Rockaway Restaurant, Spokane, Wash.; Chas. F. Rantz, New Orleans, La., 1 6-ton refrigerating plant for Fuerst & Kramer Ltd., New Orleans, La.; C. B. Atkin, Knoxville, Tenn., 1 6-ton refrigerating plant for the New Atkin Hotel, Knoxville, Tenn.; Armour Institute of Technology, Chicago, Ill., 1 3-ton refrigerating plant for experimental purposes; Bedell & Moore Building, San Antonio, Texas, 1 6-ton refrigerating plant. for cooling drinking water; Kent Company, Limited, Montreal, Canada, 1 8-ton refrigerating plant for T. Eaton Company, Ltd., Winnipeg, Canada; Holmes Confectionery Co., Portland, Maine, 1 11-ton refrigerating plant.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type is allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED—By young married man who has full charge of lighting plant at present. Has Ohio license. Will go any place that position and salary will justify. References. Address Box 141, Practical Engineer, Chicago, Ill. 9-5

POSITION WANTED—By young man, 18 years of age, as assistant engineer, fireman or oiler; 3 years' experience with engines, boilers and dynamos. Am engineer on dredge boat at present. Best of references. Address Box 143. Practical Engineer, Chicago, Ill. 9-1

POSITION WANTED—As chief engineer. Have had eighteen years' experience with steam and electrical work in central stations. Would like a position in the southwest. Moral habits. A-1 references. Address Box 142, Practical Engineer, Chicago, Ill. 9-1

POSITION WANTED—Eight years' experience in large Central Station, with steam and electrical work. Want to take charge of a small plant. Hold first class license in large city. Address Box 139, Practical Engineer. 8-2

POSITION WANTED—With Water Works Co. as Chief Engineer or Superintendent by a thoroughly practical man of long experience; is a hustler and willing to go anywhere. First class reference furnished. Box 138 8-2

POSITION WANTED—Young man, 18 yrs. of age, wishes position as oiler, helper or other minor position in power plant, where he may learn; willing to begin at bottom; some experience; moral habits, A-1 references. Address Raymond Siders, Bidwell, Ohio. Box 20. 8-2

POSITION WANTED by young man as assistant engineer in ice plant, has four years' experience among boilers, engines, pumps, etc. Address Box 140, Practical Engineer. 8-2

Help Wanted

SEVERAL RECENT GRADUATES for mechanical and civil engineering, drafting. Cleveland Engineering Agency, Rose Bldg., Cleveland, Ohio. 9-1

GOOD RELIABLE PARTY with small capital to invest in good patentable wood-working machine. This machine is a great time saver and there is a large field for a machine of this kind. For full particulars write to 1613 24th St., Two Rivers, Wis. 9-2

AGENTS TO SELL on commission, highest grade steam specialties on market. Energetic, capable specialty salesman can make big profits; none others need apply. A gilt-edged proposition for high grade salesmen from a very reliable and established manufacturer. Address W. T. Jameson, 100 Surrey Road, Mansfield, Ohio. 9-1

WANTED SALESMEN—Calling on plants using Steam for power to carry an excellent article as a side line. Write for particulars. Address Box 137, Practical Engineer. 8-tf

WE HAVE a stunning proposition for an engineer in every town or city. Little time required. Will not interfere with regular work. Write for particulars. Address Box 136, Practical Engineer. 8-tf

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 25 of this issue.

WANTED—AN ENGINEER in each town to sell the best metallic packing for steam, air, gas and ammonia. Write Ideal Metallic Packing Co., South Stillwater, Minn. 5-tf

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133 Boston, Mass. 4-tf

Wanted

COUPLINGS—Cash paid for your surplus couplings, fittings and short lengths of pipe. Write us stating what you have. The A. & J. Manufacturing Co., 425 W. Randolph St. Chicago, Ill. 9-1

For Sale

FOR SALE—3 in. by 7 in. Corliss Engine. Address 2802 Jane St., S. S. Pittsburgh, Pa. 9-1

FOR SALE—25 H. P. Olds Gas Producer Engine and Generators, complete in good running order; cost $2,500 new, will sell cheap. Hannibal Garage and Machine Co., Hannibal, Mo. 9-1

FOR SALE—"Straight line" indicator and "Victor" Reducing Wheel in cherry case, and "Willis" Planimeter. All in good condition and accurate. Price, $30. C. O. D. on examination. Address Geo. F. Osthoff, Hoisington, Kansas. 9-1

FOR SALE—Three Return Tubular Boilers, manufactured by Ritter Bros., Buffalo, N. Y. Drums 72 in. by 16 ft. Each Boiler with sixty-six 4 inch Tubes. Inspected by Travelers Indemnity Co. of Hartford, Conn. 93 lbs. steam pressure. Boilers in good condition. Can be delivered in two or three months, and seen in operation at Buffalo Bolt Company's plant, North Tonawanda, N. Y. 8-6

FOR SALE—COMPLETE SETS OF CASTINGS and material for neatly designed horizontal 1-16 Hp. steam engine. Engine has governor on cut off principle, rotary valve and adjustment for wear. A novice can build one with the help of our blue prints and instruction sheets. Castings and material, $1.50. Blue prints and instructions, 25 cents. Pat Novelty Co., Box 193, Elgin, Ill. 8-2

Patents and Patent Attorneys

FREE BOOKLET—All about patents and their cost. Shepherd & Campbell, Patent Attorneys, 500 M. Victor Bldg., Washington, D. C. 5-tf

HAVE YOU AN IDEA?—Write for our books, "Why Patents Pay," "100 Mechanical Movements," Perpetual Motions—50 Illustrations. Mailed free. F. Dieterich & Co., Patent Lawyers, 64 Oray Block, Washington, D. C. 4-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. 4-tf

Miscellaneous

"THE TOOL-MONGER"—Name given to booklet of 372 pages, which we will mail on receipt of 6 cents. Valuable to all users of mechanics' tools. Montgomery & Co., 105-107 Fulton St., New York City. 9-2

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40 page pamphlet containing a list of questions asked by examining board of engineers. Stromberg Publishing Co., 2703 Cass avenue, St. Louis, Mo. 9-1

DRY BATTERIES EXHAUSTED can be renewed for 2 cents each. Simple, scientific instructions 25 cents. Dirigo Sales Co., Bath Maine. 7-3

GREASE, OIL AND LUBRICATE your loose pulleys and shafting with graphite, mica or asbestos candles; no drip; no dirt; economical. Swain Lubicator Company, 250 Lake St., Chicago. 5-6

EVERY ENGINEER should know about the new system of Vacuum Heating which can be installed without payment of royalty. Particulars will be cheerfully furnished. T. L. Reeder, 1413 W. Jackson Blvd., Chicago.